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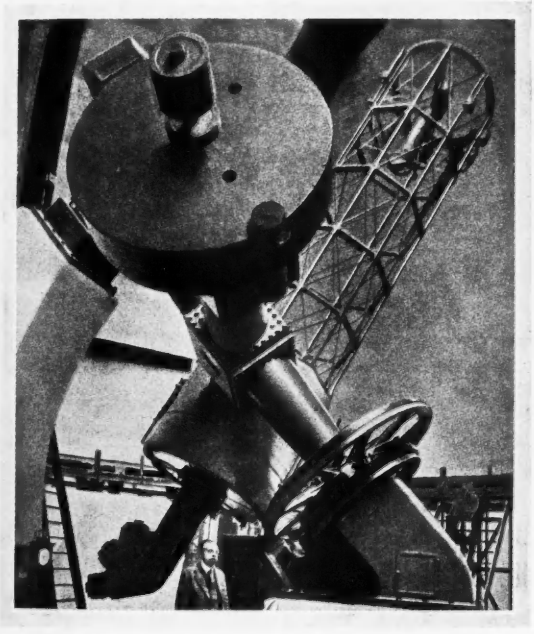

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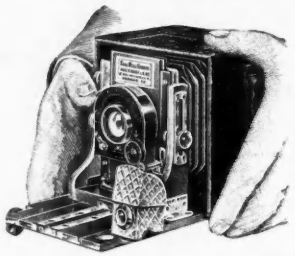

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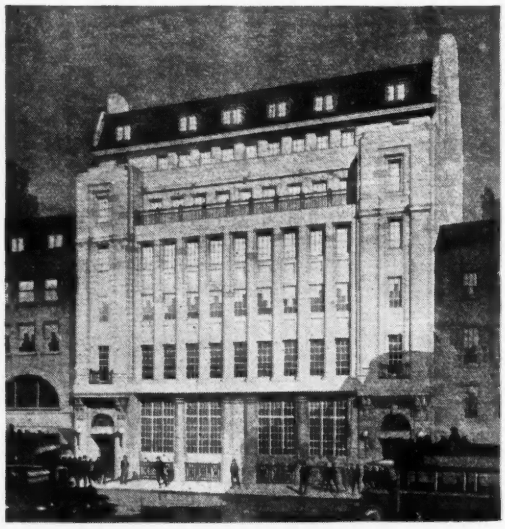

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DISCOVERY

A Monthly Popular Journal of Knowledge

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Editorial Notes.

Professor Einstein has now given to the world the results of his further researches on the theory of Relativity. To pretend that those of us who possess no special knowledge of mathematics can grasp in detail the meaning of this work is, as Euclid says, absurd. Even given a clear idea of the objective workings of the world as we know it—and few can boast the accomplishment in this age of discovery—the Professor draws a sharp line between his intellectual reasoning and the material surroundings in which that reasoning must be tested. The new conclusion, however, leads towards a greater unity in theories about the universe than has been shown before. Known as the Unitary Field Theory, it follows logically the first and second stages—the original Special Theory, and the so-called General Theory—and completes the main idea of the General Theory. This showed that gravitation is a quality of space and time rather than something imposed upon our intuitive conceptions of space and time. The new third theory proposes to embrace electrical and magnetic forces in a similar manner so that they, too, may be regarded as qualities of space and time. As Professor Einstein himself wrote in *The Times*, "Relationships of this kind, displaying an identity between different conceptions, which therefore reduce the number of independent hypotheses and concepts of field theory and heighten the logical self-containedness, are a characteristic feature of the theory of Relativity." Actually, we are told, this is not the first attempt to complete the theory in this way; whether it is more successful than the others is a matter for the future—and the experts. We have here barely noted the new work, which will be dealt with in more detail next month by Mr. H. F. Biggs of Oxford. In the same issue we shall publish Sir Oliver Lodge's contribution to our Next Step series, under the title "The New Outlook in Physics." "The immediate problem," he remarks—in words appropriate to Relativity—"is to weld the newer and the older discoveries into an all-embracing system, which shall include them all. Probably it may do so in ways which at present we can barely guess."

* * * * *

For some years past we have noted the annual progress of the Imperial College of Tropical Agriculture in Trinidad. Were he alive, Sir Arthur Shipley—who wrote frequently in our columns on the subject—would take particular pride in the 1929 prospectus and list of appointments. Students trained at the College are now employed in the following parts of the Empire, besides in various foreign countries:—

India, The Union of South Africa, Swaziland, Southern and Northern Rhodesia, Tanganyika, Zanzibar, Uganda, Nigeria, The Gold Coast, The Anglo-Egyptian Sudan, Ceylon, Malay States, Iraq, British Guiana, Jamaica, Barbados, Trinidad, and Antigua and the Virgin Islands.

This list is interesting as evidence of progress, but also as showing that the demand *does* exist for trained biologists, whose status has been so widely discussed in the newspapers in recent weeks. Official statistics suggest that the demand now exceeds the supply. The Colonies alone—most of which stand only on the threshold of development—have recruited over 500 biologists in the last nine years, and the staffs of biological institutions within the Empire now number 1,200. Commercial and other concerns, such as the Empire Cotton Growing Corporation and the Rubber Associations of Malaya and Ceylon, are making increased use of qualified scientists. Again, for example, five posts in biology at £1,000 a year were created recently at the Amani Institute in Tanganyika;

a plant breeder (salary rising to £1,600) was wanted for Iraq, and an entomologist at £1,000 a year for Barbados. These were only some of the appointments recently vacant, and in spite of attractive salaries it did not prove easy to fill them.

* * * * *

In this issue Mr. D. C. Somervell replies to the German "Reflections on the Origin of the War," which we published last month. The article was first written for a Berlin newspaper—and not for British eyes—nevertheless its author, Dr. Herz, has since sent us a letter expressing satisfaction. "I am very glad," he says, "that the opinion of a German was submitted to the English public, as I tried to lay English views before German readers." At the same time he draws our attention to a few sentences on page 52 which require correction. "Under the headline 'Poincaré is War' I wrote (contrary to your translation) that the younger Fallieres *denied* the cry of his father. I do *not* give too great weight to what Colrat wrote in 'Opinion'; and finally, I mentioned that, contrary to all probability, Poincaré *denied* having expressed himself in the way Isvolski telegraphed to Sassonov." We gladly print this correction, noting that fortunately the points were not of great importance to the main argument. As between the conflicting opinions in the two articles the reader must be left to decide. Whether any writer can picture the actions of another nation entirely without bias is doubtful, but however that may be, the new desire to face the real issues on either side is a welcome sign. History in the past has been too largely written from a national standpoint, as, for example, in the textbooks on the American Revolution. Anything approaching a final view of the War must be left to the historians of the future, but they will not have the excuse for prejudice, with which the absence of contemporary comment often provided their predecessors.

* * * * *

One of the more interesting problems studied in Greenland by the Oxford University Expedition, was the difference in coloration found in the seasonal coats of the Arctic animals. The subject was discussed a few weeks ago by the Linnean Society, to which Major R. W. Hingston read a paper. In his view the reason why certain species, such as the Polar wolf and hare, do not change to a brown coat in summer, is because at that time, owing to abundant food, there is no struggle for existence in the ordinary sense, and therefore no necessity for such change to take place. Hence the animals retain the coat which is of vital importance to them only in winter. This explanation was followed by another from Professor Graham Kerr, who pointed out that two factors are at work—the ancestral tendency to brownness, and the more recently inherited winter change in Arctic species. In a boundary zone, however, particular members of a fauna might not conform with the regular arrangement.

* * * * *

We have received a pamphlet entitled "Must England's Beauty Perish?" which Professor G. M. Trevelyan has written on behalf of the National Trust for Places of Historic Interest or National Beauty. At an increasing rate the discoveries of science are finding new applications in industry, and ever larger numbers of standard products are coming into use. Corrugated iron, asbestos bungalows, and petrol pumps are not necessarily ugly; they may, indeed, have a definite beauty of their own to which present aesthetic conventions blind us. But they have this shortcoming, that they are everywhere alike, and we are faced with a growing uniformity in our surroundings. The Professor of Modern History in the University of Cambridge is better able than most of us to appreciate history in the making and to foresee the results of the changes that are taking place in England to-day. He analyses the value of the countryside and the factors that have created it, and makes a very strong case, on grounds of pure common-sense, for the work of the National Trust. Already many places of beauty have been bought for safe-keeping, and everyone who wishes to share in this work should write to the secretary at 7 Buckingham Palace Gardens, S.W.1.

* * * * *

An improved system for the transmission of still-pictures by wireless was introduced last month by the Marconi Company. The first service opened to the public was that which has been in commercial operation between the Marconi office in London and New York since May, 1926. Some hundreds of news-pictures, cartoons, fashion plates and plans have been already sent across the Atlantic by this service. In the new system the image to be transmitted is placed on a cylinder and is scanned by a fine beam of light. The white and shaded parts of the image reflect corresponding impressions on to a light-sensitive cell. The internal electrical resistance of this cell is varied with the intensity of the light, and the electrical changes are made to modulate a wireless transmitter. At the receiving end the process is reversed. An important novelty is that the apparatus runs continuously. In addition, no special preparation of the picture is needed, another advance over previous systems in which it had first to be engraved on a copper cylinder.

Horace's Farm in the Hills.

By R. S. Conway, Litt.D., D.Litt., F.B.A.

Hulme Professor of Latin in the University of Manchester.

Further Italian excavations have now definitely confirmed the site of Horace's Farm in the Sabine hills. Having visited the district again quite recently, Professor Conway discusses the new evidence and its bearing on the poet's work.

Some years ago I had the pleasure of submitting to the readers of *Discovery* the evidence by which the site of Vergil's Farm had been identified only fifteen miles from, and in full view of, the Alps. That discovery at once explained many parts of Vergil's writings which had been obscure, and enabled us to see the natural surroundings in which the boy poet had grown up. The pictures of Horace's Farm in the Sabine hills which it is the object of the present article to make familiar to the general reader cannot claim quite the same romantic interest, because Horace was never expelled from his farm, as Vergil was, who just escaped with his life from Antony's veterans swarming in. In fact, Horace's Farm only came to him when what the Germans call "the storm-and-stress-period" of his life was behind him. Nevertheless, it is a site of interest to every lover of poetry because it was there that Horace had leisure to think out the brief but finely-touched pictures of human life and Roman ideals which ever since the world has treasured, full of haunting phrases continually used in every civilised country, generally in their Latin form—"the runaway years"—"the Golden Mean"—"a monument more lasting than brass"—"the one night that waits us all"—"the drawn sword hanging over a guilty head"—"the smoke and wealth and roar of Rome"—"when Plancus was consul" (*i.e.*, long years ago)—"thunder from a clear sky"—"the other half of my soul" (Horace's description of his friend Vergil)—"to sea again to-morrow!"—"where the last rose of summer lingers"—"keep an even mind when the path is steep"—"take in sail when the wind is too good."

Fig. 1.
PORTRAIT OF HORACE.
From a bronze medal.

When we meet such phrases, those of us who know Horace remember an old friend; and we of course are glad to learn more about him. But even for others there is a tinge of the pleasure which if not that of romance, is not wholly different, that springs from the verification of conclusions, drawn from things written long ago in books, by the visible results of recent excavation. Horace wrote a good deal about his farm, in which he took great delight, both for its own sake and because it was the gift of his patron Maecenas. This gift set him finally free to work at his poetry in congenial surroundings, instead of scribbling in such hours as he could spare from the duties of an inferior post in the Roman Civil Service. At Rome he had lived, like many young authors before him and since, the life of a poor man in rooms, probably at the top of some block of flats (as we should call them) in a hot and noisy street. In the hills he was free to cultivate his farm with his own hands and a few slaves to help, or to roam through the woods and over the mountains and by the streams, just as Wordsworth did by Easedale Tarn. So it is a kind of pleasure not to be had every day to be able to place yourself just where Horace looked out down the sunny valley, to hear the sound of the same running and falling streams, to enjoy the shadows of the same bosky or wooded hill-side, and even to tread on the actual floor of the room used for his daily meals by one of the brightest spirits that has ever charmed, inspired and tranquillized mankind. It makes a bridge for us across more than nineteen and a half centuries, into a kind of new found land, the delights of which we may add, if we choose, to our own daily store.

There is, happily, preserved to us on a medal whose accuracy there is good reason for trusting, the portrait of Horace here reproduced (Fig. 1). It suggests very well the refinement, the piercing, straightforward outlook, and the lively humour,

FIG. 2.
MAP OF THE ANIO VALLEY.
The site of Horace's Farm is marked in this map with a cross.

sympathetic though critical, which have made his poems such trusted companions.

The map (Fig. 2) will show the valley of the River Digentia, only some ten miles long, in which his farm certainly lay; and the site that has been identified is also marked.

To reach it, one first has to ascend out of the Campagna into the valley proper of the river Anio (the modern Aniene), through the narrow gate in the mountains at which the modern town of Tivoli, the ancient Tibur, stands on its own half-detached, precipitous hill, as if to keep guard over the entrance. Then still uphill, till we come to the point where the Digentia flows into the Anio; and then away to the left, through or over more than one narrow rocky gorge till we come to a more open part of the valley; but even there the hills rise up several thousand feet on either side, and the brawling river runs swiftly down at the bottom. The problem was simply this; given this valley, in which we know the farm stood, what is the likeliest spot in it to correspond with what Horace tells us about his home?

About two miles above the junction of the streams we come in sight of a tower with some buildings behind it high up on the ridge on the left, that is, on the western side of the valley. It looks down on steep slopes partly cultivated, partly still covered with bush and bracken of many colours, broken here and there by tumps and spurs of rock. This is the village of Rocca Giovine (Fig. 3), which we know, thanks to an inscription which has survived there from the time of the Emperor Vespasian, somewhere about eighty years after Horace's death, to be the village of Fanum Vacunae—that is, the Temple of the Sabine goddess Vacuna, whose name means "Peace with honour." This is a place that Horace mentions in a way which shows that this lovely point of view was one of his favourite resorts. This circumstance led some scholars to look for the site of Horace's Farm behind this village, which is itself 450 feet above the level of the Digentia. The spot they chose was remote from the valley and from any stream, and too bleak and stony to bear any of the kind of crops that Horace described. The reader will soon see from Horace's own statements, why such a site cannot be seriously considered; and, in fact, no one now defends that theory.

But a German, or perhaps I should rather say a Rhineland reader of Horace, named Nicolaus Fritsch, of Trier, made what I believe is his only contribution to knowledge by going to live for two months in the valley itself and exploring every part of it with quite affectionate enthusiasm. In 1895 he published, in an austere German annual,* the results of what we may call his walks with Horace; for readers of his long and careful study will see that he has tramped every mile of the valley again and again with Horace's poems in his pocket. I doubt if there is a single one of any of the allusions that Horace made to his life in the valley which has escaped Herr Fritsch, or any part of the valley which he has not surveyed—though I must, of course, confess that my own survey was much briefer. The result was that he indicated a particular spot on a low shoulder of Mt. Gennaro, the ancient Lucretilis, as being the only place in the whole valley of which the things which Horace wrote could possibly be true. Now since then this site has been excavated by the Italian archaeologist Lugli, whose results were only fully published in 1928, though the actual site was cleared some years earlier.

FIG. 3.
THE VILLAGE OF ROCCA GIOVINE.
In Horace's day this was named Fanum Vacunae—that is, the Temple of Vacuna—and his writings indicate that it was one of his favourite resorts.

*Fleckeisen's *Jahrbücher für Class. Philologie*, CLI, p. 57.

The photographs of it I owe to the great kindness of Mr. G. H. Hallam, who occupies a house built on the site of what seems to have been another residence of Horace, which he used towards the end of his life, at Tivoli. This Tivoli site is a most beautiful spot which, however, would require a separate article for its discussion. The Sabine Farm is that in which Horace certainly wrote the greatest part of his Odes and Epistles.

To his Sabine Farm and the Fountain of Bandusia and to Mt. Lucretilis Horace makes at least thirteen quite certain allusions and five or six others that are probably so to be interpreted, scattered over all the works he wrote after the time when he first came into possession* of the farm in 33 or 32 B.C., with the exception of the Fourth Book of the Odes, in which it is not easy to find any definite reference to the Sabine Farm; unless (as I should like to think) that was where Phyllis was invited to celebrate the birthday of Maecenas.†

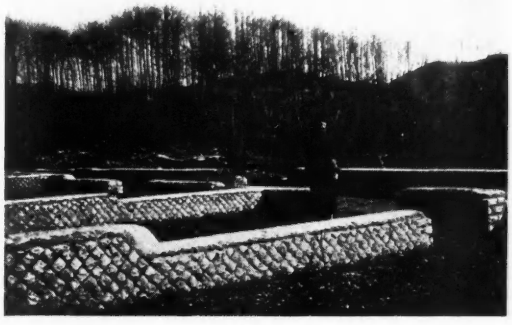


FIG. 4.
THE VILLA AND THE NIGHTINGALE HILLOCK.
The character of the brick walls (now protected by a modern coping) indicates that the villa dates from the Augustan period. The hill behind rises some thirty feet above the level of the farm.

The long description given us in two Epistles‡ tells us very fully what Horace's Sabine home was like; indeed, there are one or two points which even yet, perhaps, have not been fully considered.

Horace mentions his possession of his Sabine retreat for the first time in the Sixth Satire of the Second Book. "This is what I prayed for,—a measure of land not very large, with a pretty garden and a spring of pure water hard by the house and a little bit of woodland too. But the gods have given me something richer and better. It is good. I pray for no more than to be allowed to keep it." In the same Satire he describes his migration there as "escaping out of Rome into the mountains and my own citadel"; and in the later part of the Satire he describes his simple life free from all the burdensome fashions of the city; "nights and suppers fit for the gods" he calls them, in which, after a meal in which his slaves take part, he has some friend to talk with on quite serious subjects, interrupted occasionally by a neighbour who tells them a pretty fable of the country-side in the manner of Æsop. Twelve years or more later on he sets out to describe the same farm to another friend, Quinctius. "If you found," says he, "a line of mountains unbroken save for a gap, thro' which a valley with plenty of shade runs north and south, you would call it an excellent situation. Even the trees and bushes of the hill-side are kind enough to bear cornel-berries and plums; and both oak and holm-oak are there to shade me and feed my pigs with acorns; and the slope is so warm that you would think you were in the woods far south at Tarentum. There is a spring that deserves a name of its own, as cold and as pure as some winding river of Thrace; with water excellent for a tired head or an uneasy stomach. It is a charming retreat, lovely, I shall call it, if you will take my judgment, and it keeps me well all through the burning days of September."

Notice the word "lovely" (*amoenus*, the prettiest epithet in Latin) that Horace applies no less than five times to the scenery around the farm—here, as you see, with a little apology. No doubt the comparative treelessness of the higher parts of the mountains round about, the many rocks which break the grass, and the occasional stony screes which take the place of grass in some parts of the lower slopes, presented less attraction to a Roman eye than they do to ours—in these things Horace has what I must call a very English sort of taste; but in any case, to Monte Gennaro, the ancient Lucretilis, no traveller of our own day, if indeed, of any day, could possibly deny the epithet. The colour and shape of its purple rocky peaks and grassy sides, and the towering majesty with which it rises above the farm, its broad silvery slope glowing in the morning sunshine and spreading for miles down the valley, are all as lovely as any mountain in the world can be. Of the streamlet just mentioned, putting aside the Thirteenth Ode of Book III which Horace devoted to *Bandusia* and which I will quote later on, Horace tells us that it was rather a naughty stream, which took a great deal of "teaching" to keep within its own channel without overflowing the sunny pasture (*multa mole*

Satires, II, 6, 1-5, 60-78.
†*Ode* XI of that Book.
‡XIV and XVI of the First Book.

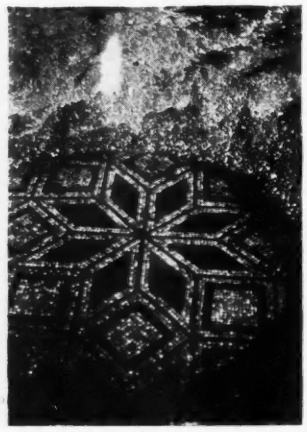


FIG. 5.
DINING-ROOM FLOOR.
The date of the villa is confirmed by the mosaic pavement still *in situ*.

docendus a p r i c o parcere prato). That description exactly applies to the rivulet as it is even to-day. When it has once fallen through and over the rocky cleft, it might choose almost any path across the e v e n l y - s p r e a d shoulder of meadow land behind and above the farm; and the channel which has been dug for it now, as in Horace's time, is clearly not quite big enough when the water is in spate. Vines are still grown, as Horace implies, on the western slopes near the house facing east-south-east; but probably none would grow on the slope looking to the north behind, where, it is now clear, was the "corner" assigned to Horace's bailiff which would "as soon bear frankincense as grapes."

Grapes, in fact, will not grow in any other part of the valley; for the low lands in the centre are too scorched by the sun—so that their ancient name Ustica, which means "burnt field" is fully justified—and the slopes of the mountains elsewhere are too steep and rocky. But the fact that this comparatively sheltered site, evenly sloping southward, will grow grapes explains* for us what has often been counted a puzzle—how Horace came by the "common Sabine wine" which he sealed up himself in his jars and which he offered humbly to Maecenas when he came to pay him a visit. We can now think of Horace as being like present-day owners of farms in Italy, who generally cultivate at least enough vines to provide themselves and their peasant-partners with wine to drink all the year round.

Now what have the archaeologists to tell us? We have to start from their welcome testimony that the remains found on the site which the photographs illustrate are certainly of the Augustan period; the chief evidence of this they find in the walls of *opus reticulatum*† which they tell us was only in use from about 50 B.C. to about A.D. 50. The date is confirmed by the character of t h e mosaics (Fig. 5) still *in situ* in some of the rooms. These remains o f t h e v i l l a t h e archaeologists therefore assign confidently to the end of the Republican period. But on the west side of these, there are also indications of baths, built at a later date, about the time of the Emperor Vespasian.

FIG. 6.
FOUNTAIN AT THE FARM.
This pretty rivulet has a fall of fifteen feet over rocks near the farm.

The site lies on a shoulder of Monte Gennaro, high above, and a quarter of a mile away from, the west bank of the Digentia, just where the stream is joined by a smaller brook coming down from the west, behind, *i.e.*, to the north of, Monte Gennaro; so that this side valley (Fig. 8) down behind the farm, provides excellent shade from mid-day onwards. The farm itself is separated on the east from the main Digentia valley by a small hillock (Fig. 4) covered with chestnut trees. The summit of this hillock rises some thirty or forty feet above the ground floor of the farm, which is therefore screened on the east from the main course of traffic up and down the valley without being shut in; and the shoulder which it occupies slopes down gently towards the south. It is sheltered from the east wind by the trees of the hillock, from the west by the slope of Monte Gennaro which lifts two beautiful rocky peaks some 2,000 feet above; and from the north by the mass of the Sabine hills (Figs. 7 and 8) which rise steeply and bleakly behind the branch valley. One of the rivulets running into this branch leaps over or through a rock about 100 feet higher than the farm, some 200 yards to the north-west (Fig. 6); and no reader of Horace need wish to deny to this fountain, with its pretty fall of fifteen feet from the cleft of the rocks, one of which is crowned by a tree, the name of Bandusia. But Mr. Hallam rightly prefers to attach the name Bandusia to the main source of the stream that runs down the valley behind the farm, the Fonte delle Chiuse (Fig. 7). The cascade from which this starts answers more closely in its details to the description in the Ode, especially in the character of the trees growing above the rock which are still holm-oaks (*ilices*), and in its accessibility to

*For more detailed discussion of this point I may refer the reader to a paper read to the Cambridge Philological Society (24th Nov., 1927) and published in its *Proceedings*; where the reader may find also a conjecture about the pine tree above Horace's Farm which he dedicated to Lucina, the goddess of motherhood.

†This name, derived from the net-like appearance of the wall (Fig. 4) is used to describe the style in which square bricks are laid with their diagonals in a vertical position, so that each brick rests, as it were, between the arms or shoulders of its two neighbours in the row below it.

the strolling flock (*pecori vago*) who would not be so welcome, or so free, within two hundred yards of the farm as they would a mile or so away up the valley. But there is no doubt that the waterfall which Fig. 6 represents is the *purae rivus aquae* that Horace extols as so healthy to drink. To that I gratefully testify.

About a mile or so further down the Digentia valley, the mountain wall on the west is broken, or nicked, high up, by a small gap in which lies the village of Rocca Giovine (Fig. 3), which we have already seen occupying the site of the ancient temple of Vacuna. This can be reached from the farm by a gently ascending path along the grassy and rocky hill-side. It is pleasant to think of Horace, perched high up beside this temple, a ruin even in his days, with the whole Digentia and a great deal of the main Anio valley spread out before him, writing the Tenth Epistle of his First Book to Fuscus Aristius, telling him that his absence is the only thing that spoils the poet's perfect happiness.

Further up the main Digentia valley rise the tall Sabine mountains with the village of Licenza upon a spur to the east (Fig. 8), the whole prospect translating in the most solid way Horace's phrase "the steep Sabine hills." Down the valley, sleeping in the sun, stretches the course of the Digentia and the Anio, so shut in at one point, some ten miles off, that it is hard to see the gap through which it reaches Tibur and the sea. One cannot wonder that in one

FIG. 7.
THE STREAM OF BANDUSIA.
Flowing down the valley behind the farm, this stream still corresponds closely in its form to Horace's description of it.

FIG. 8.
VILLAGE OF LICENZA.
This photograph of Licenza shows the character of the hills on which Horace's Farm was situated. They rise steeply and bleakly behind the valley.

of his Odes Horace expresses a distinct preference for this region as against that of "moist Tibur" bidding Maecenas come and stay with him, and not to remain in his richly-furnished villa at Tibur but to enjoy a quietly and cleanly served dinner under a poor man's humble roof.

Let me end by quoting the famous Ode to Bandusia in a rendering by Mr. Geoffrey S. Conway :—

O maiden spring, flashing thy crystal light,
Bandusia, sweet wine shall grace thee;
Decked with fair flowers' delight,
Nought can surpass thee.
And in thy honour ere to-morrow night
A young goat slain—his front a budding store
Of love and prowess, firstling pride—
Shall mix with thy cool fountain
His life-blood—Play no more,
No more, poor woolly wanton!—
Thy loveliness, mocking the Dog-star's threat
To ox and ass cool freedom granteth.
Here flocking, thy retreat
All the vale haunteth.
Thy grace amidst the praise shall now be set
Of far-famed fountains: storied through the days
The oak, whose roots do bower and fret
The hollows, laughter-laden,
Whence o'er the rocky ways
Leap down thy springs, fair maiden.

REFERENCE.

Some of these photographs I believe have not been published before; others are included in the beautiful collection which Mr. Hallam has made and generously presented to the Society for Roman Studies. Mr. Hallam himself has given a charming account in a booklet called "Horace at Tibur and the Sabine Farm" (Harrow School Bookshop, 1927) which ought to be in the hands of every lover of Horace. I cordially thank him for permitting me to use the photographs, and also Dr. Henry Guppy, the Editor of the *John Rylands Library Bulletin*, Manchester, in which some of the matter appeared in 1928.

The "Next Step."—III.

Astronomy Widens its Vision.

By A. C. D. Crommelin, D.Sc., F.R.A.S.

The construction is proposed in America of a 200-inch reflecting telescope—twice as large as any at present in existence. With this giant instrument as it were already in hand, Dr. Crommelin surveys the heavens afresh, showing what discoveries may be expected of astronomy within the next few years.

WHEN the International Astronomical Union met in Rome in 1922, the party from England halted at Florence on the return journey, where we had the privilege of looking through one of Galileo's telescopes. The object glass was smaller, and of much inferior figure, to those of many binoculars of the present day, yet that little instrument was the means of making important discoveries—spots on the sun, mountains on the moon, the crescent form of Venus, the satellites of Jupiter. But its greatest interest lay in the fact that it was the first step in the evolution of the astronomical telescope, which has now reached a wonderful state of efficiency.

Telescope Development.

The development of the telescope at first was slow. The coloured fringes that were seen round bright bodies were very troublesome, and the only remedy then known was to make the telescope very long, sometimes hundreds of feet, the object glass end being attached to a tall mast, and the eyepiece connected with it by a rod. This was a very inconvenient manner of observing, moreover it did not wholly remove the colour fringes, it only made them less obtrusive. Newton found that they were due to the fact that white light is made up of rays of many different colours, which are refracted to a different extent by glass or other transparent substances, the violet being most bent, the red least. He thought that the trouble was incurable with lenses, and so invented the reflecting telescope. This substitutes a concave mirror for the object glass, and has two obvious advantages: first, light of all colours is reflected along the same path; secondly, there is only one curved surface to be figured, instead of two in a lens, and the cost for a given size is therefore less.

About 1733 the discovery was made independently by Chester Moor Hall and John Dollond that an object glass could be made to give nearly colourless images by making it of two lenses, nearly or quite in contact, composed of different kinds of glass, crown and flint glass being generally employed. This is known as the achromatic object glass, and its use has been universal ever since in all refracting telescopes. It is to be observed, however, that the correction can only be made exact at two points in the spectrum. These points are selected differently according to the work designed for the telescope; those designed for photography bring together points further towards the violet than those intended for visual work, since the red rays have little effect on ordinary photographic plates. Photo-visual object glasses are now made; these have three lenses, the third being of Jena glass, and permit three points in the spectrum to be brought together, so that in practice the colour correction is negligible. Such object glasses are not, however, available for very large telescopes, both by reason of expense and because such a thick objective would absorb a great deal of light.

There is therefore a general agreement that all telescopes of more than 40-inch aperture (the size of the great Yerkes refractor) must be reflectors. In the last twenty years three very large reflecting telescopes have been constructed; first, the 60-inch at Mount Wilson, followed after several years by the 100-inch one there, and the 72-inch one at Victoria, British Columbia. It is true that the construction of large reflecting telescopes goes back much further than this.

Two Pioneers.

In 1789 Sir William Herschel completed his 40-foot reflector, whose aperture was 4 feet, while in 1845 Lord Rosse completed his great reflector of 6-foot aperture. In those days the mirrors were made of speculum metal, an alloy of copper and tin; they are now made of silvered glass, which has many advantages; it is less brittle, and permits of resilvering without great difficulty. Both the Herschel and the Rosse telescopes did useful work on the nebulae and the Milky Way, but their mounting would now be looked on as very inefficient. It was then considered impracticable to mount such large instruments equatorially; this is an absolute necessity for photographic or spectroscopic work. The mechanical difficulties have been long since sur-

mounted, and the modern giant telescopes can be moved and manipulated with the greatest ease.

The 100-inch telescope has already fully justified its construction by such feats as Professor Hubble's determination of the distance of the Great Andromeda nebula, and its neighbour, Messier 33, in the "Triangle." This was effected by photographs that showed extremely faint stars in the nebulae. Careful examination of these stars on different plates brought out the fact that some of them were variable; thereupon Hubble set himself to determine the nature of their light-variation, and was able to announce that they were *Cepheids*. This was a wonderful feat in view of the fact that at their faintest phase they descend to magnitude 20, which is only one magnitude above the limit that can be reached, with that giant telescope. Probably no telescope in existence would show these stars directly, to an eye looking through it, but photographs of long exposure enable us to reach objects too faint for the eye to see.

Now that Hubble has made a beginning of gauging the distances of the spiral nebulae, there is a natural desire to extend the method to systems that are still more remote. This can only be done by a further increase in the size of the objective mirror, thus enabling photographs to be obtained of stars fainter than magnitude 21, which is the present limit. The construction of a mirror 200-inch in diameter, which is now in contemplation, would give four times as much light as the 100-inch does; that is, stars one and a half magnitudes fainter than the present *minimum visible*, would be observable. Hubble's Cepheid methods could be pushed to twice the present distance; further, we should probably be able to reach some of the dwarf stars in the globular clusters and in the Magellanic Clouds. It would be of importance to cosmogony to learn whether the same proportion of dwarfs to giants exists there as in our own system.

Casting Glass.

It is a difficult matter to cast glass discs even of the size of the existing 100-inch mirror. This was cast at the St. Gobain works in France shortly before the Great War; and when delivered in America it was thought at first to be unsatisfactory, owing to some flaws in the interior of the glass. These are, however, much less important in a mirror than in an object-glass in which the light goes through the lens. When it was seen that there was no chance of making another glass disc (the factory was in the neighbourhood of "Big Bertha" and was destroyed) the one already in hand was used, and proved extremely satisfactory.

Practical difficulties arise in the efficient use of large mirrors owing to their liability to bend slightly under their own weight, and also their failure to take up a uniform temperature all over, glass being a bad conductor of heat. Either of these causes may lead to a slight change of figure, and impair the definition. Attempts have been made to remedy the second defect by using other substances, such as Pyrex or fused quartz, instead of glass; these have a much lower coefficient of expansion. It may be recalled that in the 1919 eclipse expedition to Brazil, one of the coelostats had its figure altered by the sun's heat, causing the images of stars to be distorted. To obviate a similar occurrence in the eclipse of next May, when the Einstein bending of light will again be investigated, a coelostat mirror made of Pyrex is to be used.

The Cellular Method.

With regard to the other source of trouble, the bending of the mirror under its own weight, clearly the only remedy is to make the mirror lighter. Professor G. W. Ritchey, who took a very large part in the design and construction of both the 60-inch and the 100-inch reflectors at Mount Wilson, has been engaged since 1910 in investigations to this end. He has devised what is known as the cellular type of mirror; instead of a single large block the mirror is built up from thin plates of glass whose edges are ground and cemented together. The front side is ground to a spherical shape, the back is flat. When this is complete, sheets of plate-glass, about 1-inch thick, respectively curved and flat, are cemented to the front and back of structure; the curved face is then figured to the exact shape required for perfect definition, and is silvered. Professor Ritchey is so confident of the availability of this process, even for much larger sizes than have at present been attempted, that a few years ago he boldly offered to make a mirror 300 inches, or 25 feet, in diameter, if only the necessary cost (several millions of pounds) were guaranteed beforehand. While that has not quite been realized as yet, it seems that satisfactory assurances have been obtained as regards the less ambitious scheme of a 200-inch mirror, and that we may look for the accomplishment of this within a few years.

Professor Ritchey's cellular method can also be applied to large plane mirrors, by the use of which it is possible to keep the large curved mirror in a fixed horizontal position, thus obviating the necessity for a very large dome. There would also be a number of secondary mirrors of different curvatures receiving the rays after reflection from the 200-inch mirror, thus

giving a great range of possible focal lengths, of which the most suitable for the class of work in hand can be selected.

One of the first essentials in erecting an observatory with a very large telescope is to choose a site where the air is both clear and steady. Mount Wilson is quite good in these respects, but some still better sites have been found in the semi-desert regions of Arizona. The Lowell Observatory at Flagstaff is in this region, and all the observers there have spoken enthusiastically of the climate and the definition.

Mapping the Heavens.

Professor Ritchey shows his breadth of ideas not only in planning huge instruments, but also in designing co-operating groups of observatories in different latitudes. The first one would be in the neighbourhood of 40 degrees north latitude; the others would follow, each 20 degrees further south than its neighbour, down to the limit of 40 degrees south. Without going more than 15 degrees from the zenith of each observatory, they would cover between them 80 per cent of the whole heavens. Many of the great observatories of the United States have already established subsidiary stations in South America, such as the Harvard College southern observatory at Arequipa, Peru, which has enabled the Harvard series of photographs to be extended from pole to pole.

What are the results that may be hoped for if this supergiant telescope is successfully erected? I have already spoken of the important additions to our knowledge of the spiral nebulae and the globular clusters that it is likely to bring. Within our own stellar system it should bring into view all the stars except the extreme dwarfs which may be situated on its outer borders. When the Royal Astronomical Society was inaugurated 109 years ago, it laid down as one of its aims the formation of a catalogue of all the stars, even those requiring powerful telescopes to see them. Such a scheme, however, has long been recognized as being far beyond the resources of astronomy. The late Professor Kapteyn suggested a useful compromise; he mapped out a number of "selected areas" uniformly distributed over the heavens, saying that if these were thoroughly explored they would give nearly as much information as if the whole sky were covered. We need have no doubt that the proposed telescope will be applied to these areas, and will help to probe them to their depths.

The study of stellar spectra is rapidly advancing, and a great amount of information regarding the size, density and temperature of a star is now derived from the character of its spectral lines. It will be possible to extend this work nearly two magnitudes below its present limits. Such delicate researches as photographing the spectrum of the faint companion of Sirius should be made easier.

It is likely that the telescope would be employed far more upon the stellar heavens than upon the orbs of the solar system. For the study of the planetary surfaces, refracting telescopes of moderate size are probably more effective. But the 100-inch was used in producing the finest lunar photographs that have yet been obtained, and a corresponding advance in such photographs may be hoped for with the aperture doubled. The study of the planetary temperatures with a delicate thermopile, such as has been carried out in recent years by Coblentz, Lampland, Pettit and Nicholson, would also gain by the larger aperture. More exact results might also be looked for in the determination of the rotation periods of Uranus and Neptune by the spectroscope. Thus, even in the fields of work at present in progress, a notable increase of efficiency should result, and there is little doubt that a great increase of optical power will suggest new lines of research.

I cannot forbear from quoting, by way of conclusion, some lines from Alfred Noyes's poem "The Torch-bearers" describing his visit to Mount Wilson, when the 100-inch reflector was first tested on the heavens.

To-morrow night they hoped to crown the toil
Of twenty years, and turn upon the sky
The noblest weapon ever made by man.
War had delayed them. They had been drawn away
Designing darker weapons. But no gun
Could outrange this.

"To-morrow night"—so wrote their chief—"we try
Our great new telescope, the hundred-inch.
Your Milton's 'optic tube' has grown in power
Since Galileo, famous, blind, and old,
Talked with him, in that prison, of the sky.

And now our hundred-inch. . . . I hardly dare
To think what this new muzzle of ours may find.
Come up and spend that night among the stars
Here on our mountain top. If all goes well,
Then, at the least, my friend, you'll see a moon
Stranger, but nearer, many a thousand mile
Than earth has ever seen her, even in dreams.
As for the stars, if seeing them were all,
Three thousand million new-found points of light
Is our rough guess. . . . "

To-morrow night! For more than twenty years
They had thought and planned and worked. Ten years had gone,
One fourth, or more, of man's brief working-life,
Before they made those solid tons of glass,
Their hundred-inch reflector, the clear pool,
The polished flawless pool that it must be
To hold the perfect image of a star.

How Time Signals are Broadcast.

By F. Addey, B.Sc., F.R.A.S.

The time signals that are now a feature of the British wireless programmes have roused the curiosity of many listeners as to how correct time is obtained. The new plans at Greenwich and Rugby are here described.

About a year ago a world wide service of wireless time signals was commenced from the Post Office high-power station at Rugby. In connexion with the introduction of this service the standard clock installation at Greenwich Observatory has been entirely remodelled.

For fundamental time determinations the earth rotating on its axis is taken as the standard clock. A telescope, called a transit telescope, which can move up and down but cannot deviate from the north-south direction—that is, from the plane of the meridian—is used as the hand of the clock, and the stars are used as the figures on the dial. The time taken for the earth to make one rotation, or the time which elapses between two successive passages of any star across the meridian, is taken as the unit and is called a " sidereal " day. A suitable point on the sky is chosen for the zero point on the dial, and then the exact " sidereal " time at which any star will come due south can be calculated.

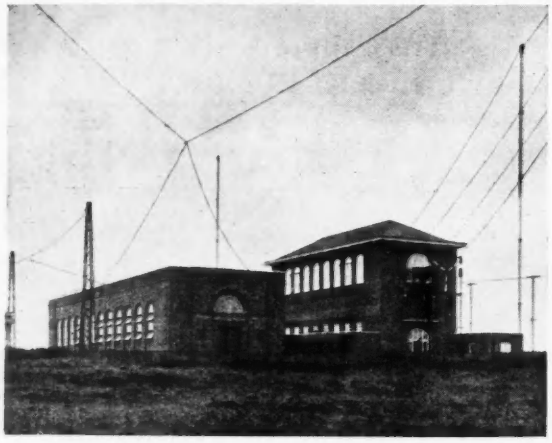
Time from the Stars.

As the earth rotates the stars appear to move from east to west, and if the telescope is pointed up at a suitable angle any particular star will be seen to move through the telescope field as it passes across the meridian. The times at which the star will reach definite positions in the telescope field can be accurately calculated, and these times are compared with the corresponding indications of the observatory clock. When the star enters the field of the telescope a movable cross-wire is set upon it and, by turning a milled head, this wire is kept coincident with the star during its passage through the field. As the star passes certain known positions in the field an electrical contact is automatically closed which sends a signal to an instrument called the " chronograph." This consists of a slowly rotating drum covered with paper on which a fountain pen traces a line. The closing of the contact on the telescope causes the pen to be jerked sideways by means of an electro-magnet, so that the line is displaced. A contact on the observatory clock is also connected to the same electro-magnet, and the seconds beats of the clock are recorded in the same way. A special signal, sent by the clock at each exact minute, enables the clock time corresponding to any particular second mark to be determined. Thus by afterwards examining the chronograph record the clock signals can be very accurately compared with the star signals. Since the correct times of the latter are known the error of the clock can be found. The standard sidereal clock is never altered, but its error is continually determined in the way just explained, and recorded.

Correcting Errors.

The determination of the error of the observatory clock at the times when the observations are made would be of little use if the clock itself did not run regularly between the observations. By successive star observations the rate at which the clock is gaining or losing can be ascertained. If this rate remains steady the correct time at any instant can be obtained by applying the correction deduced from it to the time actually shown by the clock. The utmost ingenuity of clockmakers has accordingly been exerted to produce a clock of which the rate will be constant. There is no need for the standard clock to keep exact time, in fact, no clock ever does so, but the amount it gains or loses per day must be as uniform as possible.

The standard sidereal clock at Greenwich Observatory is one of the " free pendulum " clocks devised by Mr. Shortt and manufactured by the Synchronome Company. This clock is a development of the " Synchronome " electric clock invented by Mr. Hope-Jones. In the latter a weighted arm, normally held up by a catch, is released at each half minute. In falling, this arm first gives an impulse to the pendulum, which keeps it swinging for the next half minute, and then closes a contact which energizes an electro-magnet by which the arm is automatically restored to its original position, where it is again held by the catch. This arrangement is called a " remontoir." The pendulum as it swings has to actuate a certain mechanism which brings about the periodic release of the remontoir, and also has to close any necessary contacts for signalling the time to indicating dials, etc. This work prevents the pendulum swinging absolutely freely, and so interferes with its exact time-keeping functions.



THE RUGBY WIRELESS STATION.

From this building the daily time signals are broadcast. Their great value to astronomers and geographers may lead to a more frequent service of signals.

To overcome this drawback, Mr. Shortt conceived the idea of separating the time-keeping duties from those of driving any necessary mechanism. He provides two pendulums instead of a single one. One of these pendulums, known as the " master " pendulum, has no work whatever to do, except to continue swinging as regularly as possible. It receives an impulse each half minute from a remontoir, but it does not release this remontoir itself. A second pendulum, known as the " slave " pendulum, performs all the functions of working the necessary remontoir and signalling mechanisms. At each half minute the slave pendulum releases the catch of its own remontoir, and also that of the remontoir of the master pendulum. The latter remontoir does not actually drop, however, until the master pendulum is at the middle point of its swing. Thus the time of falling of the master pendulum remontoir is under the control of the master pendulum itself. When this remontoir does drop, the contact which it closes to bring about its restoration to the position of rest, as described above, is also utilized to signal back to the slave pendulum and to work a device associated with that pendulum which automatically corrects it. The slave pendulum is arranged to lose slightly, and the correcting device accelerates it sufficiently to keep it in step with the master pendulum.

In order to make its motion as free as possible, the master pendulum is enclosed in an airtight cylinder from which most of the air has been removed. At Greenwich Observatory, the master pendulum is placed in an underground chamber, a relic of the old castle which previously occupied the site, and the temperature of this chamber is maintained as uniform as possible.

The rate of the free pendulum clock is so constant that, whereas with the sidereal clock previously in use it would have been unsafe to go more than a week without checking the clock with the stars, it would now be possible to go for two or three months without a check, and still to know the correct time. Of course, the clock is never allowed to go unchecked for such a long period. A number of star observations are made every clear night, but cloudy weather may sometimes last for several successive days, and it is then that the advantages become manifest of having a clock which can be relied on to run steadily.

For purposes of everyday life, however, sidereal time would be unsuitable, as, owing to the motion of the earth round the sun, sidereal " noon " may occur at any time during the day or night, according to the time of year. Our lives are controlled by the sun, and therefore we have normally to use solar time. The lengths of the days shown by a sundial are not exactly the same throughout the year, due to the

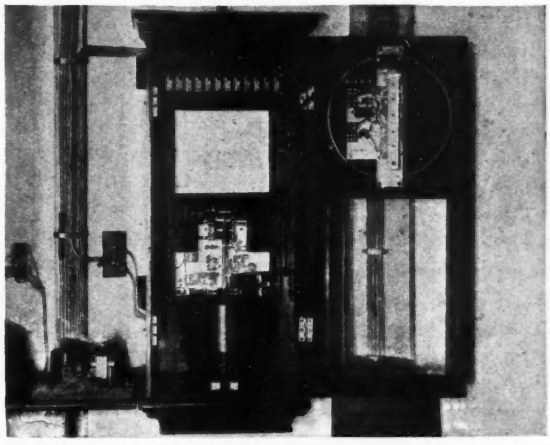
CLOCK HOUSE AT GREENWICH OBSERVATORY.

Here are housed the various clocks from which the accurate time is obtained, before being transmitted to the Rugby wireless station.

variations in the earth's motion round the sun. An average length of day is therefore taken, and is used as the unit. Time based on this unit is called " mean time," and as for this country Greenwich is taken as the standard place for time reckoning, the time we use is called " Greenwich Mean Time."

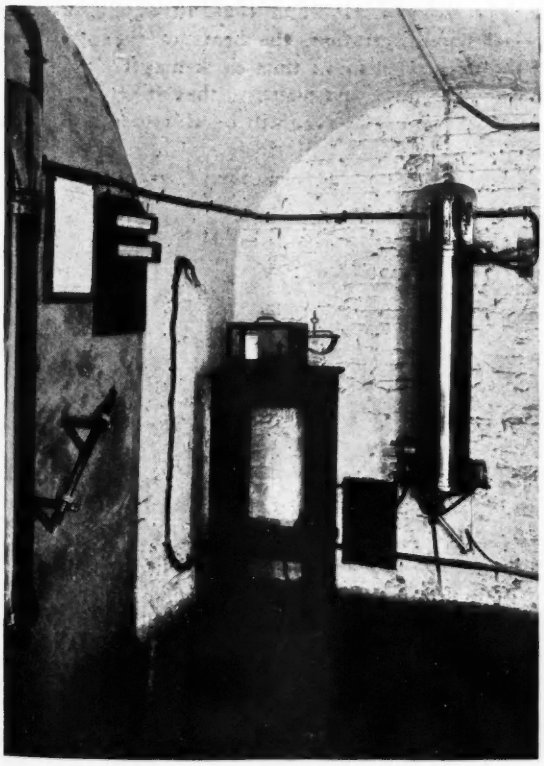
The standard mean time clock at Greenwich consists of a free pendulum and slave, similar to the standard sidereal clock. Unlike the sidereal clock, however, the mean time clock which sends out the time signals for public use must be kept to correct time. It is compared before each important time signal with the sidereal clock, the indications of which are, by a simple calculation, converted into mean time.

Any error in the mean time clock is put right by a device known as the Airy magnetic corrector. Fixed to the pendulum of the clock is a magnet, the poles of which move over the ends of two coils of wire. By sending a current of electricity through these coils in one direction or the other the force exerted on the moving magnet can be either added to or subtracted from the force of gravity. In the former case the pendulum is accelerated and in the latter retarded. The length of time during which a current of given strength has to be sent through the coils to produce any desired correction in the time indicated by the clock is known. Thus when its error has been determined the clock can at once be adjusted to show correct mean time.



WIRELESS TIME SIGNALS.

The clock is here shown open so as to expose the works, the dial being behind the door. From this clock at Greenwich the time signals are sent to Rugby.



THE SIDEREAL CLOCK CHAMBER.

The temperature is maintained as uniform as possible in this underground chamber, which is a relic of the old castle previously on the site of the Observatory.

In addition to the ordinary slave pendulum, the master mean time pendulum governs the pendulum of a clock which is provided with a number of electrical contacts. This clock drives the large twenty-four hour public clock placed in the Observatory wall by the main entrance. It sends a time signal once an hour to the General Post Office. This signal is used to synchronize clocks and to ring time gongs or actuate other time indicating devices at the premises of subscribers to the time service. It also sends signals to the British Broadcasting Corporation on the last six second beats of each exact quarter hour and half hour. These signals are used by the B.B.C. for the six-dot time signals which it radiates, usually at 6.15 p.m., but which could, if necessary, be sent out at any other exact quarter hour as well.

At 10 a.m. a more extended service of time signals comes into operation. By means of automatic switches, controlled by clocks synchronized by the time signals, certain telegraph lines from the General Post Office in St. Martin's-le-Grand to provincial towns, and certain lines from these towns to out offices, are, just before 10 a.m., disconnected from their telegraph instruments and joined through to Greenwich. At the out offices the lines are extended to indicating apparatus at the premises of subscribers

to the time service and to public time indicators. The 10 a.m. signal from the Greenwich mean time clock is thus distributed over the country.

The mean time master pendulum also controls a special pendulum which sends out the Rugby time signals. These signals are intended for the use of navigators and explorers who need to know accurate Greenwich time in order to find their longitude.

The longitude of a place, or its distance east or west of a standard place, is measured by the difference between the local time at the place, and the corresponding time at the standard place. The local time is determined by observations of the sun or stars. The corresponding time at the standard place, for which Greenwich is usually taken, is found from chronometers.

These are clocks which are made to keep time very accurately indeed. Even the best chronometer, however, cannot be depended on to keep absolutely correct time, so that before the advent of wireless telegraphy, every opportunity had to be taken of checking its indications from the time signals supplied to various ports by astronomical observatories. As a guard against the danger which would result if a chronometer went wrong at sea and the error were undiscovered, it is usual for all important ships to carry three chronometers which are compared one with the other.

The advent of wireless telegraphy has immensely simplified the problem of the determination of longitude. Observatory standard time signals are now sent out at different times of the day from many high power wireless stations, so that a ship can keep her chronometers under constant check.

The Rugby signals consist of a series of dots lasting from 9.55 a.m. till 10 a.m. and from 5.55 p.m. till 6 p.m., the intervals between the beginnings of the dots being 60-61 seconds in length, with half second dashes instead of dots at the exact minute. By having the dots spaced at intervals of less than a second the wireless signals periodically come into step with the beats of the chronometer which is being checked. By noting the time shown by the chronometer and the number of the dot at which coincidence occurs, it is possible, by an easy calculation or from tables, to ascertain the error of the chronometer to an accuracy of one sixty-first of a second.

The commencement of the Rugby broadcast time signals marks the latest step forward in the methods used for the distribution of time. The hope has recently been expressed by a leading astronomer and geographer that at no distant day Rugby may broadcast a time signal every hour instead of only twice a day, and that ultimately, from a special wireless station, the beats of the pendulum of the Greenwich mean time clock may be broadcast continuously, day and night, so that at any time and at any place an observer will be able to compare his clock with the standard clock at Greenwich and so ascertain correct Greenwich time.

Reflections on the Origin of the War.

By D. C. Somervell.

A translation of a German article with this title was published in our February issue. That article took as its text the "History of Western Europe, 1815-1926" (Benn's Sixpenny Library) by Mr. D. C. Somervell, who here replies to Dr. Herz and reviews the subject through English eyes.

Dr. Ludwig Herz, it need hardly be said, did not write his article for English readers; he wrote with the excellent object of putting before his own countrymen a typical English statement of the causes of the Great War. The object was excellent, for, as he said in the last sentence of his article, "So long as we do not know the views of foreigners we shall talk over one another's heads in the discussion." My own purpose is not so much to reply to him as to follow his example. Just as he took my book as an illustration of the British attitude, so I propose to take his reflections upon it as an illustration of the German attitude.

First of all, it is to be noticed that Dr. Herz is preoccupied with the question of *war-guilt*; and he is, it seems, agreeably surprised that the offensive term does not appear in my book. We British are not, I think, any longer preoccupied with the question in that form. We hold, as a matter of history, that the German Government, and the German nation which allowed that Government to exist, were much more to blame than any other Government and nation for the tragedy of the Great War. But we hold that opinion as an opinion about a point in bygone history, just as we hold that the French Government and nation were mainly to blame for the wars of the French Revolution and the English Government and

nation mainly to blame for the Crimean War. There is, of course, this difference, that the penalties for those past wars have, if the phrase may be allowed, long been paid, and the penalties for the Great War are still in process of being paid—by vanquished and victors both; but our attitude towards present-day Germany is not affected by our opinion of the criminality of the German Government and nation in 1914.

The Nemesis of Versailles.

We may regard the German attitude as morbid, but the Allies themselves have to bear a share of responsibility for it. Among the many unwise clauses of the Treaty of Versailles one of the most unwise was that which inserted in the Treaty a clause by which Germany was compelled to admit that she and her allies were wholly responsible for the war. "Wholly responsible" is in any case a rash claim, if it implies, as of course it does, that none of the allied nations had contributed in any way, by lack of wisdom or lack of virtue, to the catastrophe. But apart from the absurdity of the phrase "wholly responsible," it was wrong to force upon Germany such an acknowledgment. It could have no moral validity. The responsibility for the war is not to be determined by such crude assertions and enforced admissions.

That wrong cannot now be undone, for a formal cancellation of the clause is unthinkable; but it seems to us that certain very obvious steps might be taken which would go some way to help the German people to put the past behind them as we have done. Germany has already been restored to her normal position among the nations, so far as matters of business are concerned. She is on the Council of the League, and a signatory of the Treaty of Locarno. Has not the time come to supplement these business relations with those courtesies of international intercourse, which count for so much more than matters of business in the minds of simple people? I regret, for example, very much that the occasion of President Hindenburg's eightieth birthday was not made an opportunity for telegrams of congratulation from our King and our Prime Minister. I do not believe that one in a thousand of those who lost sons or husbands in the War—in this country at least—would have disapproved.

Dr. Herz, then, is preoccupied with the question of war-guilt. He sets out, by means of quotation and summary, the material in my book bearing on the subject. In that book there is a chapter which contains a brief description of the positions and policies of the six European Great Powers on the eve of the War. Dr. Herz then proceeds to his criticism of those descriptions, and what has he to say?

What he says and what he does not say is surely extraordinarily significant. He criticizes very rigorously, though from his point of view perfectly fairly, what I say about the position and policy of each of the Allied Powers. He quotes, but without any criticism or discussion at all, what I say about Germany. And what I say is sufficiently severe. I will quote some of my own words from Dr. Herz's quotation:—

> Thus an atmosphere of international unrest, of recurring crises, and of rumours of wars was absolutely necessary, not to the Germans, but to the maintenance of the Hohenzollern system. The militarists could only be secure so long as Germany was insecure. They therefore cultivated insecurity.
>
> If insecurity was needed Austria furnished the commodity in abundance, for here was an anachronism much less tenable than Bismarck's. . . . It seems probable that the party (of Francis Ferdinand) had already resolved on war with Serbia before his assassination provided them with a pretext. . . . Germany gave Austria a free hand against Serbia, because the conquest of Serbia would abolish the one obstruction between Austria and Turkey, and give Germany continuous control "from Berlin to Baghdad."

All this is passed without criticism. In other words, the German argument is not to attempt to prove the innocence of Germany but to disprove the innocence of the Allies. To that point I now pass.

The Serbian Problem.

Dr. Herz "firmly disputes" my statement that "the complicity of Serbia in the murder of the successor to the throne was not proved," but he immediately adds that "it has never in any quarter been seriously asserted that the Serbian Government as such had a hand in the game." I should have thought it had been so asserted, but let that pass. My statement was vague, and misled Dr. Herz. By Serbia in that sentence I meant the Serbian Government. I agree with him that the complicity of certain high Serbian officials is now admitted, and he will agree also, I trust, that I by no means whitewash Serbian policy in general. (See page 59 of the book.)

But for us in England the question who murdered that Archduke has almost nothing to do with the allocation of war-guilt. The crucial point is that, a month after the murder, Austria sent Serbia an ultimatum demanding an investigation of the circumstances of the murder, under Austrian supervision, in terms surpassing any ultimatum ever addressed in modern times by one Government to another: that Serbia accepted, say, nine-tenths of those demands, going thereby to the utmost conceivable

limits of compliance, and that Austria rejected the Serbian reply and thus let loose the deluge. Austria would not have acted thus if she had only desired a satisfactory judicial enquiry into the murder; she acted thus because, as I said in a sentence that Dr. Herz quotes and does not dispute, she had determined to seize the occasion to obliterate Serbia from the map.

With regard to France Dr. Herz admits that "it is certainly true that France would not have sought for a pretext for war for the lost provinces," but he adds a number of qualifications to that statement. They amount to this, that French statesmen realized that a European War was possible and even probable in the near future, and they were determined that, if such a war took place, with or without their participation, they would use the occasion to extort from Germany the cession of Alsace and Lorraine. I should think this is quite true. It is interesting and important, but does not throw upon France any share in war-guilt.

British Attitude.

As for England, Dr. Herz says that I ought to have found room for an account of the differences in the Cabinet during the days preceding 4th August. Well, I was writing a very short book on one hundred and twelve years of history, and my subject was primarily continental Western Europe. The divisions in the Cabinet were a superficial and ephemeral excitement. When the time for irrevocable decision came the Cabinet was united with two exceptions, and who were they? Morley and Burns! The one a man always more eminent in literature than in politics, a man of seventy-five who, by his recent resignation of the India Office, had already gone half-way in retirement from active life, and the other a worthy ex-trade union official who, apart from the affairs of his own department, had long ceased to count for anything in political life, a man of whose existence, it may fairly be said, the general public had long ceased to be aware. As for "the influence of the war party on the Cabinet—especially of General Sir Henry Wilson, Maxse, the editor of the *National Review*, Amery, one of the wildest men in Parliament" —Asquith, Grey and Haldane did not require the assistance of these gentlemen in making up their minds. As for "the war-supporting letter of the Conservative party" it was eminently right, and demonstrated that the declaration of war was with us a national and not a party decision.

Dr. Herz wonders if the British public as a whole was as "pacific" and as uninterested in the European situation up to the eve of the 1914 crisis as I have suggested. He reminds us that earlier crises ought to have awakened our attention. Perhaps they ought, and temporarily no doubt they did so. But after Agadir in 1911, unprecedented domestic excitements supervened, and monopolized our attention. We were also given to understand that in 1912 and 1913 our relations with Germany were more amicable than they had been at any time since the Conference of Algeçiras in 1906. And this was in a sense quite true, for the German Government was during those years occupied in negotiating with the British Government a treaty in settlement of various Anglo-German extra-European differences, as, for example, in connexion with the Baghdad railway, and this treaty was in fact drawn up and ready for signature when the war broke out. In form this treaty was exactly similar to the treaties with France and with Russia that had made possible the Anglo-French and Anglo-Russian *ententes*, and those of us (a minority) who thought about the matter at all, confidently hoped that the Anglo-German treaty would prove a firm foundation upon which better relations with Germany could, and would, be built. It now seems probable that for the German Government this treaty was merely a desperate bid to secure our neutrality in the forthcoming and "inevitable" war. We were the more deceived; but that merely brings us back to my point—our ignorance and our innocence.

United Public Opinion.

There is much that is of interest in the latter part of Dr. Herz's article, but it exhibits perhaps a certain failure to see the wood for the trees. What though *John Bull* said this, *Truth* that, and *Punch* the other; what though the *Daily News* disapproved of Lord Northcliffe and *The Times* (very strangely as it must seem) was unable to forget Bismarck's affront to Mr. de Blowitz. The plain fact is that as soon as the British public had got the essential facts into its head it was as nearly unanimous as any country not actually threatened with invasion can be expected to be. The action of the Government was opposed only by a minute minority, composed of saints, freaks and fanatics, such as would have opposed any war under any conceivable circumstances.

But we would return to the point from which we began. For us these things are matters of history, and do not prejudice our judgment of post-war Germany. We respect the German Republic; we give it our good-will and desire its good-will in return; and I, in particular, would thank Dr. Herz for the fair and friendly tone in which he has discussed and criticized my little book.

The Influence of Sound on the Cinema.

By Francis Carver.

Within the past two months the "talking picture" has spread rapidly in London theatres, where it is already a serious rival to the silent cinema. Whether the latter will hold its own is an important problem. Will the resources of cinema art, as yet hardly developed, be usurped by the new hybrid?

DURING the nineteenth century a revolutionary change took place in the normal conditions of life. This period finds some expression in literature, a medium which perhaps then reached the culminating point in a development started by the invention of printing; but the age is particularly barren in pictorial art. A technical mastery which was the result of centuries of development found itself quite unsuited to the new conditions, and attempted to find inspiration in working over the ground of its early struggles. This era, barren of achievement, was remarkable for a particularly rigid and copious code of theory, which put anything of mechanical origin outside the pale of art. Photography in particular was condemned, and the invention it rendered possible, by which a series of pictures could be used to create an illusion of movement, was regarded as a clever but negligable scientific toy. The toy caught the public fancy, and the simplest scenes of life wavered and flickered uncertainly across the screen; and as the novelty wore off, enterprising showmen began to present short dramas.

Stage Traditions.

Early films rigorously followed stage tradition, for the camera was always at a fixed distance from the actors, and the proscenium arch frequently appeared in the picture. But even as an entertainment the film was an outcast, so that no reputable actor would allow his name to be associated with it, and D. W. Griffiths, to whom are traceable nearly all its initial developments, took up production to earn a living which he could not make as an actor. Thus the cinema grew up in a world of untried abilities and hard cash, where the word art had hardly ever been heard. Even within this stifling atmosphere the cinema has developed away from the theatre, and has won for itself a unique place in modern life. The extraordinary thing is that even now films are shown and appreciated for their attributes of drama and of the personality of actors, while attention is hardly ever paid to the principles which distinguish the cinema from every other medium. So now that the art of the cinema seems likely to be eclipsed, there is no body of opinion to lament it. The synchronization of sound has been presented as a development, and as such it has been generally accepted, whereas it is really a complete negation of the basic principle of the cinema. For this reason any inquiry into the effects of the invention must be prefaced by a consideration of those principles which it will so radically affect.

Cinema Principles.

The art of the cinema is peculiarly the product of the age, for it is based on the use of a mechanical contrivance, and it employs the principle of division of labour. It was born with the invention of the moving-picture camera, a recording device which is sensitive to light, but not to sound. Consequently a fundamental principle of the cinema is that it must achieve all its effects through the use of pictures. The first step is the construction of compositions, either by the deliberate lighting and grouping of objects, or by choosing a group of objects which fall into a composition when surrounded by a frame. In either case the result to be achieved is the satisfactory covering of a flat surface with areas of light and shade. But though born deaf and dumb, the camera can record motion, and it is into the development of this factor that the cinema has been forced by its other limitations. Confined though its progress has been, it is already a familiar aphorism "that the first duty of moving pictures is to move." The difficulty of expressing complex ideas in pictures, and the necessity for keeping to the conventional dramatic form, has led to the use of captions. But the printed word has little value in composition, and none in motion, so that it is "not cinema"; though it may be an unavoidable confession of inability to cope with the medium.

The Ballet serves as an example that pure movement can be used to achieve an effect, but the Ballet is confined to the use of human figures. To the cinema literally anything which moves is material to be selected and used to affect the emotions of the spectator. The myriad diffuse movements which compose life, and especially modern life, begin to fall

into place on a scale of value; and the deliberate combination of several movements abruptly plunges one into the sphere of visual rhythms. We are already equipped to create and appreciate musical rhythms, but this faculty is as yet scarcely developed in the eye. This, and not the dramatic factor, is the essential of the cinema.

Rhythmic Movement.

Pure cinema, then, is the combination of pieces of movement into a rhythmic whole which will excite a direct emotional reaction in the spectator. The unit of motion is the scene, or shot, which is an unbroken strip of film recording continuous action. The scene seldom lasts more than ten seconds on the screen, and is often limited to a mere flash. The action in a scene may be formed by the movement of actors, or of inanimate objects, or of a combination of both, such as action against a background of traffic. The speed at which the action of each scene occurs has some relation to a norm for the film, which will be dictated by the character of the story, or the temperament of the director. This is the *tempo*, by differing from which retarded or accelerated action in individual scenes becomes significant. Thus the slow, tragic *tempo* of "Vaudeville" expressed the character of the story and the German nationality of the Director, while it set off the Fair scenes. In direct contrast to this is the brisk *tempo* of an American comedy. The eye is very quick to register an impression, and can rapidly digest a series of pictures, so that the cinema can create some effects in a few seconds which it would require on the stage several minutes of dialogue to build up. Not that the one is consequently better than the other, but merely that their limitations, and therefore their spheres of action, are different. The power of conveying an impression by a rapid succession of images makes the cinema independent of the time unity which the stage is forced to observe.

Although the action of any one scene may have a rhythmic quality, it is chiefly when echoed or complemented by that of a succeeding scene that it is revealed, much as a note only acquires significance in its place in a melody. This piecing together of shots is known as "cutting." The actual length of each scene has its own effect, for a rapid succession of shots will produce excitement, and a sequence of scenes of diminishing length, a feeling of acceleration and impending crisis. This timing of cuts provides a framework through which the action is threaded, for the feeling of acceleration created by shots of diminishing length will be greatly increased if the action in each scene occurs at a slightly greater speed. In every case cutting implies the use of action in one scene in relation with that of another, so that action crossing the screen which is echoed by a reverse movement induces balance, while action continued through several scenes, a sense of unrest and crisis. Conversely, every piece of action is significant, in that it may have some relation with another, so that rhythm grows out of action almost of its own accord.

Since the cinema derives its power from the need to express itself in terms of motion, the introduction of sound works a radical change not merely in technique, but in basic theory. The new conjunction is not a pictorial art, but a hybrid which has still to discover its limitations, and to establish its line of development. From the point of view of the talent upon which it will have to draw, and of the attention paid to it, its situation is more promising than that of the cinema has ever been. But talent will be hampered by the same commercial considerations which held the cinema in check, and so far there has been little evidence of an intelligent use of the sound film, or of any attempt to research into its possibilities. But the cinema has developed in spite of unpromising material, largely through its own impetus, and the crucial point is, whether the sound film has any equally great possibilities to force it along the road of development.

A Transitional Stage?

The first impression made by a "talkie" is one of dissatisfaction at the conjunction of sound with a flat monochrome image. The sound makes one conscious that one is looking at a picture, which is only acceptable in so far as it achieves an illusion of reality. The sound film is therefore probably in a transitional stage, which will be ended by the introduction of colour photography, and of stereoscopic projection. The effect of these inventions would be to produce an apparently solid and naturally coloured image on the screen, which would create a perfect illusion of reality.

The sound film is apparently closely related to the theatre, but in reality it is much more dependent on principles which belong distinctly to the cinema, for it relies on a recording device. A play is the work of an author, plus the abilities of the actors on a specific occasion, while a film is a concrete object which is only half made when the action is recorded, and which remains as unalterably the same when it leaves the hands of the artist as does a novel or a picture. Just as all the possibilities of the cinema

can be traced back to the camera, so should it be possible to predict those of the sound film from the existence of the camera which is sensitive to both light and sound.

One of the most important characteristics of the camera is its complete mobility. It can record action taking place over large areas of country, and can show concurrently action occurring in two hemispheres. Space means nothing to it, and clearly the stage unity of place has no application. But in a more limited sense, the camera can adopt any point of view to a piece of action, and this point of view will be passed on to the audience; whereas in a theatre, every spectator has a different point of view to the action of a play. The value of the camera angle in creating an impression has already been proved by the cinema, though the mental stimulus in the case of an apparently solid image would be different from that of a picture.

The camera is by nature selective. At present it deals in two dimensions, but even in the case of stereoscopy there would be the question of the grouping of masses towards the camera's single point-of-view. The combined mobility and selectivity of the camera have a strong dramatic function, for they can present any object to the spectator with equal emphasis, merely by causing it to occupy the same area of the screen. Size is relative merely to the limits of the picture, so that a collar-stud may have as much dramatic value as a cathedral. Thus the enlarged screen used in one form in "Wings," and in another in "Napoleon," really weakens contrast by destroying the absolute scale. The cinema and the sound film both secure dramatic emphasis more through the resources of the medium than through the performance of the actors.

Eye and Ear.

The rapidity with which the eye can receive impressions absolves the cinema from the unity of time, and sets it free to accelerate or retard action, and to evolve rhythms with but little reference to the absolute speeds of reality. But on the stage we demand that the lapse of time supposed to occur during an act, shall approximate to the actual time for which the scene plays, and that larger intervals shall be indicated by the fall of the curtain. This convention has much of its origin in the fact that speech sets the *tempo* for a play, and speech cannot be accelerated or retarded. Hence, although the lapse of time during a whole sound film does not have to be arbitrarily divided into acts, yet each scene or sequence of scenes containing extensive dialogue must be conducted at a *tempo* which approximates to that of reality. Such a *tempo* would be satisfactory to the ear, but would appear to the eye as intolerably sluggish. Further, ineffective visual rhythms have been eked out by music, but "The Terror" showed that dialogue cannot be combined with a continuous accompaniment.

It is impossible to say exactly what the result of this limitation in the speed of action will be, but it is at least arguable that this age has motion in the blood. Even if we do not really appreciate the cinema factor in moving pictures, we may well feel its loss, and it is possible that audiences will not tolerate a drastic slowing down in visual rhythms. In this case the sound film will have to limit dialogue, and concentrate on the myriad other sounds which compose reality. Footsteps, the rustle of clothes and roar of traffic will be its material. Finally, although action must be limited by the compromise with sound, it is implicit in the mobility of the camera; for the camera does not judge movement by the time taken to cover any fixed distance, but by the time it takes to cross the screen, and this depends on the distance of the object from the camera. The movement of a hand which would be imperceptible on the stage, acquires a high motion value in "close-up."

New Problems.

The cutting of synchronized sound and movement presents new problems, for although the eye will accept a rapid series of images, the corresponding sequence of sounds might well produce a jarring discord, or even an entirely different psychological effect from that created by the image. Further, sight and sound rhythms are on a different plane, so that it will require much experiment before the relative sounds to a visual rhythm will form a recognizable audible rhythm. The cinema is representational, and creates its rhythms out of the movement of natural objects, whereas music is non-representational, and creates its own sounds, thus the co-ordination of natural sounds cuts across all preconceived ideas of audible rhythms. Colour also brings its own problems when it comes to presenting a rapid succession of images. It is common cinema practice to cause one scene to dissolve into another, or to achieve an effect by the superimposition of one image upon another. Colour will limit the mixing of two scenes, and it is doubtful whether the mind would accept a superimposed image in the case of the illusion of solidity. Stereoscopy is a necessary consequence of sound, but it is sure to limit technique, and the pictorial expression of ideas.

Although national temperament is bound to play

an important part in its development, a pictorial art is far more international than those which employ speech. In the case of the cinema this is particularly important, for its place as a popular spectacle makes it a strong antidote to insularism and the hostility of prejudice. If the sound film relies to any great extent on dialogue, it must be confined to a strictly national development, and its international appreciation must be limited to the particularly well educated. The question is further complicated by the economic issue, for most countries are unable to make enough films for their own consumption, so that an important international trade has grown up. The only full length sound pictures which have as yet been shown in England have been of American manufacture, and the large majority of them must continue so to be.

Accent.

It seems rather illogical that they should have been criticized for the accent of the dialogue, and one is reminded of the tourist who was amazed at the fluency with which even the school-children of Paris talked French. After all, English cinema audiences have been steadily absorbing American ideas and institutions ever since the war, and it is not a very far cry to accepting the American accent, so long as it is used in scenes of American, and not English life. It is also beside the mark to criticize "talkies" for the imperfection of the sound reproduction, for it can only be a matter of time before this objection is removed.

We are told that it is no longer possible to sell a silent picture in America, and although England has been more cautious in her attitude, we are too much an adjunct of the American market to be able to think for ourselves for very long. Besides, American and English popular taste has been steadily corrupted, and one would hardly expect the silent cinema to make a stand here. France will be less easy to conquer on account of the language difficulty, while the *avant-garde* cinemas of Paris have given some weight to the small body of French who really appreciate the art of the cinema. Germany, on the other hand, absorbs a comparatively small proportion of American films, and has a very high artistic standard in production. All classes attend films which are considered either too good or too bad to be shown in England, according as to whether the opinion is that of exhibitor or censor, and the cinema is appreciated, not as a narcotic, but as an artistic medium. Directly after the Russian Revolution, a small band of enthusiasts in Leningrad started to make films. Their efforts survived plague, famine, and civil war, and in 1924 the industry was practically nationalized. Political considerations aside, it must be admitted that Russian pictures are sincere and idealistic, and are, as far as the expression means anything, thirty years ahead of the rest of the world. Not only are these two countries to be regarded as strongholds of the legitimate cinema, but they are bound to exert a great influence on France and England when their pictures are more widely diffused. The inevitable reaction to silence will have all the weight of a fresh influence behind it. Whatever may be the commercial success of the sound film, the cinema will always be the medium for the individual artist.

Hitherto "absolutes," or exercises in pure cinema, have had a great experimental value, but the fact that they are the expression of a single mind working outside the commercial field will lend them an even greater importance in the future. Amateur pictures of a more conventionally dramatic type are usually less interesting, but there is a future for the film which can be very cheaply made.

Cameras and materials are slowly becoming cheaper, and "Berlin" demonstrated that a non-dramatic film can be made which combines human interest with a purely cinematic form. At present manufacturers are developing small cameras using a narrow gauge film which cannot be used in ordinary projectors. This is a serious consideration, for if artists and experimenters are forced to use sub-standard stock, they will be absolutely cut off from the public, and their influence will be greatly decreased.

The struggle now in progress is not between advanced and conservative opinion, but between an artistic medium with proved abilities, and a hybrid which is as yet untried. It would be rash, with the example of the cinema before us, to say that the Ugly Duckling may not have immense possibilities, but at the same time it must be remembered that the resources of the cinema have hardly been tapped, and it would be a great loss to the world if its progress were to be arrested.

The Five-Day Week.

THE publishers of *Discovery* desire to remind its readers that their offices are closed regularly on Saturdays. Enquirers will therefore save personal inconvenience by avoiding calling on that day. Messrs. Benn Brothers introduced a five-day week for their entire staff as long ago as 1916. In view of the publicity aroused when the same practice was followed by the Ford Motor Company not many months ago, it is interesting to record that the publishers were among the pioneers in this new welfare movement.

The Excavation of Roman Britain.

By R. E. M. Wheeler.

Keeper of the London Museum.

Four military sites of first importance during the Roman occupation of Britain are at present under excavation, besides civil remains of various interest. Dr. Wheeler here discusses the recent discoveries.

THE exploration of Roman remains in this country was long a genteel occupation for the leisured landowner, who thus sought to enrich the romantic memories of his Aldine Vergil and his Italian tour. Times have changed. Some of the most accurate and important excavations of Romano-British sites during the last thirty years have been carried out by men who neither knew their Vergil nor had set foot in Italy. Day after day indifferently accurate descriptions of these excavations are read in the newspaper press by intelligent readers to whom Vergil is not even a name. It is increasingly difficult to allocate all this busy exploration to its proper context, and it is proportionately desirable that from time to time some account should be rendered of the modes and motives whereby some six or seven thousand pounds are spent yearly, in workmen's wages alone, for the digging of this Roman Britain.

FIG. 1.
A DEDICATORY OFFERING.
Bronze figurine of a wolf-hound, discovered in the Roman Temple now under excavation at Lydney, Gloucestershire. (Actual size.)

For it may at once be admitted that the indefinite digging up of Roman remains is not likely to add materially to the sum total of human knowledge. Our museums are full of such remains, almost *ad nauseam*. We can never know appreciably more than we now know of the total achievement of Roman Britain in the matter of architecture, of sculpture, of pottery, of the hundred and one domestic arts and crafts. Professor Haverfield has directly or indirectly familiarized every schoolboy with the fact that the Romans *Romanized* Britain; that between A.D. 43 and 410 the Romans imposed a system of sanitation, syntax, arterial roads and professional military service that changed, quite suddenly, a group of heterogeneous civilizations and an amorphous countryside into something comparable with modern England. In concise books and papers, easy to read, Haverfield outlined clearly the general nature of this transformation, and it may now be affirmed that any piece of work which does not add definitely and materially to Haverfield's own achievement is waste of time. The inexpert digging-up of Roman villas, the unnecessary exploration of second-rate forts, are now extravagances which British archaeology should not be called upon to bear. Perhaps twenty per cent of the annual expenditure on field-work is still thus frittered away. Nevertheless, much important work is being done, much remains to be done. Let us first take stock of present effort, and then look for a moment to the immediate future.

Haverfield died in 1919. Throughout his work he had insisted upon the geographical and political division between the military frontiers and the civil hinterland of the province, and that fundamental distinction is now established beyond the need of further emphasis. But there is a third division, or perhaps sub-division, which, by 1919, had barely emerged as a significant entity. During the past decade, the extent and nature of the *peasant-life* of Roman Britain have been revealed by survey and excavation in a new light. In the Lowlands of Scotland, in Wales, in southern England, have been discovered new evidences of a flourishing native peasantry which was affected only superficially by

the arrival of the Romans. This peasantry lived in small villages of circular or oblong huts of prehistoric type, usually of timber but sometimes partly of stone. Air photographs of such villages in the Salisbury Plain area have shown recently that they are associated with elaborate groups of small square fields, and carefully selected excavation has proved that these field-systems, in one place or another, endured from at least as early as 500 B.C. to at least as late as the fourth century A.D. This identification of a prehistoric agricultural system in southern England (due to the acuteness of Mr. O. G. S. Crawford) is indeed one of the most striking discoveries of recent British archaeology.

Nor was this native agriculture confined to the southern downs. Other similar field-groups, marked out often by means of rough standing stones, adjoin Romano-British hut-villages on the uplands of Carnarvonshire, and it cannot be doubted that further search will reveal similar traces elsewhere. But indications of field-baulks and of timber huts are hard to detect, save on the sensitive surface of the chalk. Now and then some other chance-circumstance may help in unexpected places. A few years ago the stumps of circular wooden huts of prehistoric type, preserved by the alluvial mud, were found in association with great quantities of Roman pottery on the foreshore of the Thames at Tilbury. More recently (1928), a search for prehistoric pile-dwellings which were suspected to exist on the foreshore of the same river at Brentford revealed remains of such a dwelling with all the features of known prehistoric examples; but Roman pottery upon its wicker floor (Fig. 2) and Roman tiles beneath it showed that here again we are confronted by a prehistoric tradition in a Roman environment. Whether these cottagers likewise organized their tillage into orderly allotments like those of the downs, cannot be said. But it is at least becoming clear that even within the purlieus of Londinium—one of the five greatest Roman cities north of the Alps—the peasantry was still content to live in the pile-dwellings and circular hovels which had sufficed their forefathers before the Romans came. Here, and in the Wiltshire villages and the kraals of the Welsh and Scottish hills, lay un-Romanized Britain—un-Romanized save for the intrusion of the foreign crocks, ornaments and coins, the efficiency and convenience of which had struck a death-blow at the native crafts.

FIG. 2.
ROMANO-BRITISH PILE-DWELLING.
Part of the wicker floor of a Romano-British pile-dwelling, dug up at low-tide level on the foreshore of the Thames at Brentford, 1928.

Thus to Haverfield's two Estates must be added a third; that of the native agricultural peasantry, which interpenetrated and transgressed the frontiers of Roman military and civil officialdom, and held its own until the destroying Picts and Scots from the north had harried its fields, and until the Saxon invaders, with a rival agricultural system of their own, had, in southern England, driven it from the high downs that it had held for at least a millenium.

The peasant, however, has by no means banished the legionary from the fore-front of Romano-British archaeology. The normal approach to that study is still the "Life of Agricola," and the normal goal the frontiers which are largely based upon his work. Nor can it be said that, on the whole, the excavation of our military remains has been seriously "overdone." Let us glance at the present position.

It is a familiar fact that the back-bone of the Roman army of occupation consisted of the legions, quartered characteristically along the base-line of the frontier at York, Chester and Caerleon-on-Usk. In the fourth century, when the increasing assaults of the Saxons necessitated the formation of a permanent rearguard for the province, one of these legions was transferred wholly or partially to Richborough, on the Kentish coast. It may thus be said that there are *four* legionary fortresses—*i.e.*, military sites of the first importance—in Britain. All these are at the present moment in process of excavation.

The circumstances of these four important excavations vary considerably from one another. At York and Chester relatively little of the Roman area is now sufficiently free from medieval or modern buildings to provide spade-room for the archaeologist.

Nevertheless, at York the skilful excavations carried out in gardens and back-yards by Mr. S. N. Miller, of the University of Glasgow, have begun to throw a flood of light upon the history of the fortress. At one corner the earlier (second and third century) fortress-wall has been revealed nearly to its original height, and at another the famous "multangular tower" has been found to represent not a mere local rebuilding but a complete re-planning and re-designing of the fortress to meet the new strategical and tactical conditions of the fourth century A.D. In that last stormy century of Roman rule, York was the military capital of Britain, and Mr. Miller's reconstruction of the history of the fortress will be in effect a reconstruction of a phase of British history.

At Chester, Professor Robert Newstead is slowly and carefully excavating Roman barracks in the only considerable open space now available. Roman Chester again has its special niche in history. It was the first of the legionary stations permanently occupied by its legion (about A.D. 50), and, in the re-entrant between Wales and northern Britain, it was the pivot of the original Roman frontier-system. Later it may have formed one of the last outposts against the invading Irish whose keels "whitened the waves of ocean" in the last years of the Roman occupation.

The excavation of the third of the legionary fortresses, Caerleon in Monmouthshire, is in a very different case. Here, instead of a close-built modern town, a straggling village still leaves one half of the fortress free for exploration; and, as ill luck will have it, instead of the leisurely conditions which attend

FIG. 3.
ROMAN INSCRIPTION FROM CAERLEON.
This marble slab, six by four feet in area, records a dedication to the Emperor Trajan. It was found last year in the legionary fortress at Caerleon.

FIG. 4.
THE BARRACKS AT CAERLEON.
Roman barrack-building excavated in the legionary fortress at Caerleon, Monmouthshire, one of the four chief military sites in Britain.

the excavations of the sister-fortresses, the archaeologists at Caerleon are working against time upon land which is already in process of "development" and is therefore archaeologically doomed. An enterprising newspaper saved the well-known amphitheatre for the nation. For the rest, Mr. V. E. Nash-Williams, is rapidly laying bare the defences, barrack-blocks (Fig. 4) and other buildings in the threatened areas. The system of towers, etc., added to a Flavian clay rampart about the year A.D. 100, are the most elaborate of their kind, whilst the barrack buildings, each nearly one hundred yards long, with their regular systems of rooms for non-commissioned officers and men, are the largest yet discovered in this country. Built about A.D. 75 with structures largely of timber, the fortress was reconstructed in stone in the time of Trajan, and the most striking "find" in 1928 was a large marble slab, 4 feet by 6 feet, bearing a building-dedication to that emperor (Fig. 3). After partial renewals in the third century, the importance of the fortress seems to have waned, and it is probably significant that the period of diminished occupation there coincides approximately with the transference of the garrison, or of some part of it, to Richborough.

Here, at Richborough, for seven years the Society of Antiquaries, through Mr. J. P. Bushe-Fox, has systematically explored the interior of the Roman fortress. As one of the first sites in the country occupied by the invading Romans and, for similar reasons, one of the last to remain in immediate contact with the Roman world, Richborough is potentially one of the key-sites in our early history. The excavations have shown that at or about the time of the invasion of A.D. 43 a large legionary camp was

built here, with timber buildings of which the remains were partly uncovered during 1928. Later the site became a peaceful port—next to London itself, the premier port of Britain. After the middle of the third century the raids of Saxon pirates demanded the re-fortification of a part of the headland. First a small square camp with triple ditches and then the great stone fortress which still towers over Sandwich were raised, probably by the successors of those legionaries who had earlier built Caerleon. And the presence of many thousand late Roman coins in the soil within the fortress indicates something of the extent to which these massive fortifications were sought during the last troubled days of Roman Britain. The problems to which the mass of late coinage gives rise are already creating a literature of their own.

Hadrian's Wall.

If we turn from the four legionary fortresses, the most important of the remaining excavations on military sites are those connected with the two Walls. On the Antonine Wall, which for forty years formed the northern frontier of the Roman Empire, a complex of buildings has been unearthed by Mr. A. O. Curle and Sir George Macdonald at Mumrills, within the largest of the guardian forts. But the more southerly and enduring frontier, Hadrian's Wall, now presents the more intricate series of problems—problems which are the more elusive since in some cases they seem to relate to changes of policy during the actual process of construction rather than to the direct influence of well-defined historical events. The group of structures—roads, forts, watch-towers, earthen vallum, turf wall, wide stone wall and narrow stone wall—from which, between A.D. 80 and 130, grew up the final frontier-system that is now associated with the name of Hadrian, is full of difficulties, and their patient exploration is primarily the work of Mr. F. G. Simpson. Recently the focus of Mr. Simpson's activities has been the fort of Birdoswald, where the mysterious turf rampart converges upon the stone wall which, in this sector, it preceded. When Mr. Simpson's work has been completed, we shall have advanced far towards a reconstruction of the history of the great frontier-line which ranks amongst the most splendid antiquities of Europe.

Away from the two frontier-lines, the recent exploration of the minor forts has yielded little of special note, save that the uncovering by Mr. P. K. Baillie-Reynolds of the little fort at Caerhûn, south of Conway in North Wales, has given us once more the almost complete plan of a small auxiliary fort. Nor has the investigation of non-military sites—towns, villas, etc.—been carried very far. Sites of this character, lying in the comparatively settled districts behind the frontier-zones, necessarily reacted less readily and obviously to the frontier warfare of which most of our fragmentary history is made. Nevertheless they can tell us much that the barracks and watch-towers cannot. Their careful excavation can show how the civilian population (which, after all, represented the essential life of the province) waxed and waned; how it expressed itself, now magnificently, now meagrely, in its public and private buildings and in its local fortifications; and, above everything, how it fared in the last days of the occupation, when the Roman emperor Honorius, hard pressed by nearer foes, bade "the cities of Britain" fend for themselves. These problems are vital to the early history of the country, and it is therefore sad to think that hitherto no Romano-British town, and hardly a Romano-British "villa," have been excavated scientifically in accordance with modern standards.

During the past year only one civil site has been attacked on any adequate scale. At Lydney in Gloucestershire, the Society of Antiquaries at Lord Bledisloe's invitation has begun the re-excavation of a remarkable site which was partly explored a century ago. Within a "promontory camp," constructed about the first century B.C., a Roman temple, dwelling-house or hostelry and other structures, were built within a precinct-wall during the last half-century of the occupation. The temple was of exceptional and, indeed, unique plan. It was a basilica, with a triple shrine and an extraordinary array of side-chapels at regular intervals round its periphery. At first sight it suggests nothing so much as a Christian church; but its pagan dedication (to a native deity named Nodens) is known, and there can be no doubt that, built about A.D. 365, it was designed for one of the late Roman semi-mystical cults which had something in common with, and were at one time serious rivals to, Christianity itself. (See Fig. 1.) The temple is thus of outstanding interest as an unusual architectural monument of the most critical period in the history of European religion.

The Future.

Such are the main lines of current Romano-British field work. What of the future? One thing at least is clear. If we add to the major works already enumerated all those of lesser value which have likewise been attempted in recent years, it is evident that we are excavating beyond capacity. Certain qualifications are demanded of the efficient

excavator: scholarship, experience, literary ability and (not least) knowledge of mankind and power of command. These qualities are less commonly combined in one individual than might be anticipated. Men with less comprehensive qualifications may be of sterling worth on an excavation-staff, but they are not fitted to direct. At the present rate of endeavour there are not enough qualified directors to go round.

One result is that Romano-British field-work is falling sadly into arrears in the matter of publication. St. Augustine said that it is better to dig than to dance; he might have added that it is easier to dig than to publish. Save on those sites which are actually threatened with destruction, the time has arrived to call a temporary halt in the field and to concentrate effort upon publication. General Pitt-Rivers, the "father" of British field-archaeology, long ago remarked that the date of a discovery was the date of its publication. Excavation without publication is sheer destruction of evidence—a hard saying which is increasingly true in proportion to the thoroughness of the excavation.

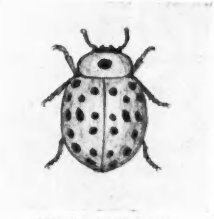
A partial solution of this difficulty may be found in enlarging the facilities for training on a few of the major sites. This brings me to the final point. No branch of British field-archaeology can compare with that relating to Roman Britain as a practical basis for a sound general archaeological training. On Roman sites alone can be guaranteed for the student a sufficient richness of material, clearness of stratification, and variety and interest of technical problems to ensure an adequately comprehensive experience in the basic principles of field work.

A Study in Insect Evolution.

By T. F. Marriner, F.E.S.

Ladybirds as a rule are carnivorous feeders, but the writer's new study shows that the 24-spot variety is exceptional. Like an older family of beetles from which the ladybirds are believed to have sprung, the 24-spot is a vegetarian, and thus appears to be a link in the chain of insect evolution.

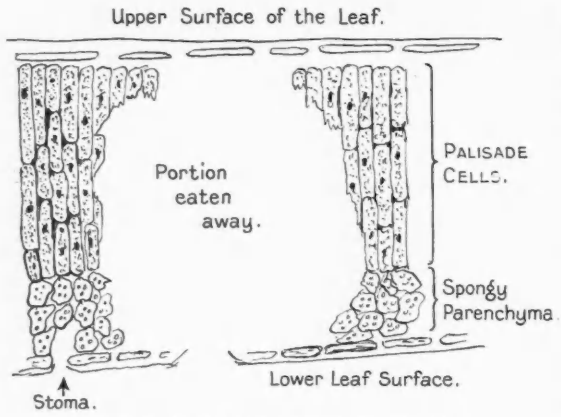
ALTHOUGH most readers of *Discovery* possess some general idea of what beetles are, yet chiefly because of their mode of life these insects are not nearly such familiar creatures as flies, moths, or bees. The beetles, however, are by far the most numerous order of insects, and there is probably no other branch of insect or animal life which offers so large a virgin field for discovery and research. Up to the present we know the life history and the capabilities for harm or usefulness of but a small proportion of this numerous order. Their study affords some extremely interesting sidelights upon problems of heredity and evolution. Like the human race, in our own islands the oldest forms appear in the west country. Did the beetles then spread westward like the people and were they also driven further and further west by successive invasions from the east? Whence did they come and when? Do the beetles react to a new environment as plants, animals and humans do, and how does this reaction affect the gradual development of new species? We have much to learn before we can fully answer such questions, and at whatever point the student enters upon the study of beetle life he is soon brought face to face with them, and so, if he be in earnest, given an added zest to his work.



24-SPOT LADY BIRD.
Magnified 15 times.

The tiny ladybird which forms the subject of the present article has never been recognized either as a pest or as an aid to man in his work; its life history has therefore presented no economic value and hence it has been left alone. But the insect is decidedly interesting from a scientific point of view, for, as will be seen, it is a link in a chain of evolution. The little creature was born scientifically in 1758, in the *Systema Naturae*, Tome II, of Caroli A. Linné. It was rechristened on many occasions afterwards and finally became generally known as *Sub-coccinella 24-punctata*, or the 24-spot ladybird. It is a tiny red-coated animal in which the typical form has twenty-four black spots upon each wing case. It is found all over Europe, in Algeria, in the Caucasus, as far east as Persia, and in some parts of the British Isles.

According to evolutionists, the family of *Coccinellidae* (ladybirds) to which the 24-spot belongs is an offshoot of an older family known as the *Chrysomelidae*. Now the latter are all vegetarians, while the ladybirds are carnivorous, feeding upon plant lice. But the 24-spot



SECTION OF LEAF TO ILLUSTRATE FEEDING.

(with its closest foreign relatives the *Epilachna*), while having the form and specific characters which make it a ladybird, is yet purely a vegetarian like the progenitors of its family. Here then we have in it an evolutionary link between the two families, and the study of its life history makes this more evident.

It may be interesting at this point to describe something of the way in which the secrets of such a tiny insect are learned. The usual method of capturing the 24-spot is by sweeping among mixed herbage with a sweep-net. Before the worker can set about rearing the insect he must discover the plant or plants upon which its eggs are laid and its larvae feed, but when knowledge upon this point is vague it is sometimes a difficult task. In the writer's researches, a large box with glass sides and a gauze top had its floor covered with a grass sod, in which was planted a specimen of every plant found where the insect was swept up. Into this a number of the insects were turned loose as early in the year as they could be found, generally May in the north country areas. If the box be placed in the sunshine, the insects, like other ladybirds, will mate readily. In this way three clusters of eggs were obtained on 31st May. These were taken and put under observation in smaller cases on the leaves upon which they had been laid. It was found that the average period of incubation was about four days in captivity at ordinary room temperature. Another batch was put out of doors under gauze and these hatched out on the fifth day.

The first meal of the newly-hatched larva consisted of a portion of its egg shell, then after a rest it turned upon its nearest neighbour, killed and devoured it. On 7th June a number of the larvae were placed each in a separate small glass-topped box, and by close and careful watching it was found that they passed through four periods, called instars, when they cast off their skin and appear in a new suit before entering the chrysalis or pupal stage. The average duration of the larval life was found to be twenty-two and a half days. The experiments were repeated in the following year with practically identical results.

Pupation took place in much the same way as that of the 2-spot ladybird,* and the average period was found to be between seven and eight days.

The larva of the 24-spot is yellowish in colour and more oval than that of the usual ladybird larva, being, in fact, much more like the larva of some of the *Chrysomelidae* group, another point in the evolutionary link. The method of feeding is very interesting. It feeds upon what botanists term the palisade cells of the leaf tissue, working through to these from the back of the leaf where the outer leaf skin is softer. The upper skin of the leaf is left intact. (See accompanying diagram.) As a result of their eating away portions of the inner tissue of the leaf, the surrounding portions take on much the same appearance as do the edges round a bite in an apple if left exposed, turning into small yellowish-brown blotches similar to those made by the larvae of certain Tineid moths. When a number of the larvae have been feeding upon one leaf the whole underside becomes spotted with these brownish blotches. So far it has been discovered that the larvae of the 24-spot feeds upon the following plants, besides a few others :—Soapwort (*Arundo phragmites, saponaria officinalis*) ; Bladder campion (*Silene cucubalis*) ; sea campion (*Silene maritima*) ; white goosefoot (*Chenopodium album*); scentless mayweed (*Matricaria inodora*).

Hibernation.

As the 24-spot has never been recorded at a greater height than some six hundred feet, it may be regarded as a lowlander. The hibernated insects leave their winter quarters usually in May, and as the total time from egg laying to maturity is about thirty-four days, the progeny of these hibernated insects is on the wing about the end of June. These mate, and then die off in July. Their eggs hatch out, and larvae are abundant in late July and early August. These reach maturity and go into hibernation about the beginning of September. In the laboratory breeding cases they sought winter quarters at the roots of the grasses and plants, and probably out of doors also they hibernate in this way, for in winter they can often be shaken out of the roots of grass or moss.

* Described in *Discovery*, December, 1926.

Cosmic Rays: Messages from Space.

By A. Vibert Douglas, Ph.D.
Macdonald Physics Laboratory, McGill University.

The study of rays emitted from the depths of space has recently given rise to new ideas about the creation of the universe. The work of Professor Millikan, already noted in "Discovery," is here dealt with in particular, although a solution of the problem has yet to be found.

It is always of special interest to watch the way in which an advance in knowledge in one branch of science may provide the solution of an apparently hopeless problem in another branch. This has happened time and again in astronomy and physics, until to-day their problems are so interwoven that the physicist in his laboratory and the astronomer in his observatory may be in very truth searching for the same thing.

An Astronomer's Problem.

Penetrating radiation is just such a problem—groped after by the astronomer, detected by the physicist, partly understood, and then so amplified by further experiment as to be again a source of great mystification; further discoveries raising it to a position of primary cosmical importance.

When first the astronomer realized that the Andromeda nebula was a spiral aggregation of myriad stars, far out in space beyond the utmost limits of the Milky Way, and estimated its mass to be one thousand million suns, he was mystified by the fact that its total output of light was only one three-thousandth of what was to be expected from so much matter. Why is Andromeda nebula so faint? was the problem to which no answer was immediately forthcoming. And so the astronomer quietly put this problem away upon the shelf of his memory and turned his attention to other matters.

About the year 1902 at McGill University, Montreal, Sir Ernest Rutherford was beginning to feel his way into the innermost recesses of the atom in his early researches in radioactivity. He was led to suspect that anywhere and everywhere on the surface of the earth there could be detected a very penetrating radiation which would pass through a considerable thickness of lead. One of his associates, H. L. Cooke, confirmed this suspicion experimentally, detecting beyond all doubt the influence of this penetrating radiation. Somewhat similar investigations had been carried on independently at Toronto by Dr. J. C. McLennan. Following up this discovery, Dr. A. S. Eve, at McGill University, calculated the intensity gradient of the penetrating radiation, that is to say, the rate at which its intensity diminished as one ascended above the surface of the earth.

Some time later two continental physicists, Kohlhörster and Hess, making use of balloons to attain greater altitudes, discovered that although the penetrating radiation decreased with height until a certain altitude was attained, it then began to increase again. This was of great importance, pointing for the first time to a source of penetrating radiation external to the earth. Thus there were seen to be the two sources—the radioactive elements in the crust of the earth emitting a constant supply of *gamma* rays more penetrating than the hardest known X-rays, and an unknown source outside the earth from which penetrating radiation is poured into our atmosphere continually.

The next step in this tale of discovery was made by Dr. Kohlhörster, when he ascended the Jungfrau and set up his instruments in an ice cave. Here he detected radiation more penetrating than any known *gamma* ray and found furthermore that this cosmic radiation was most intense when the Milky Way was crossing the zenith.

A Physicist's Explanation.

About this time Dr. R. A. Millikan began similar observations in the Rocky Mountains. His results seemed to indicate very little diurnal or seasonal change in intensity. Another series of observations pointed to an increased intensity when the Great Nebula in Andromeda was on the meridian, and no sooner was this announced than the astronomer seized upon it as the explanation of his old problem—why is Andromeda nebula so faint?

The explanation seemed self-evident. The energy which is generated, just how we need not now specify, in a star or in a nebula meets with many vicissitudes on its way out into empty space. In getting to the surface of a star, it encounters millions upon millions of atoms, being absorbed and radiated again, emerging after each encounter slightly longer in wave-length because of the slight loss of energy consequent to each

encounter. Thus, what was originally very penetrating radiation is frittered down to light waves and heat waves by the time it escapes from a star. In escaping from a nebula, however, the density and opacity are so low that a large proportion of the radiant energy leaves the nebula in its original highly penetrating form, and much less of the energy has been reduced to the range of wave-lengths of visible light. Thus the nebula appears faint because a large proportion of its radiant energy is invisible.

One astronomer, basing his judgment upon the results obtained by Kohlhörster, concludes that the source of the cosmic rays is within our Galaxy, emanating probably from the nebulous matter in instellar space, this diffuse matter being chiefly found near the galactic plane, that is to say, in the Milky Way. Another astronomer, influenced more by Millikan's results, comes to the conclusion that the spiral nebulae are the source, and as they are believed to be fairly uniformly distributed over the entire celestial sphere, this would agree well with the observed constancy of intensity.

The Latest Study.

This is how the problem stood a short time ago, but during the last six months Millikan has published an account of his latest study of cosmic rays and the inferences which he draws from the new facts obtained. In order to understand the line of argument, a word must be said about his method. The intensity of radiation can be measured by the rate of discharge of an electroscope, the penetrating power of the radiation being found by screening off the electroscope and finding how much of the radiation is absorbed by the screen. The more penetrating the radiation the greater the thickness of the screen through which it passes, and the lower will be the "absorption coefficient." Now Millikan used water as his absorbing screen. The absorption caused by the earth's atmosphere is equal to that which would be caused by a water screen ten metres thick. Millikan enclosed his instrument in a watertight case and lowered it beneath the surface of a lake high up in the Rocky Mountains, taking readings down to a depth of 200 feet. Cosmic rays reaching to this depth are of such penetrating power that they would go through 18 feet of lead.

The results were most interesting, indicating that the cosmic rays fall into three distinct groups having different absorption coefficients; for the softest group, 0.35; for the second group, 0.08; and for the most penetrating group of rays, 0.04. What can this signify? Millikan's first conclusion is that evidently the rays do not come from the annihilation of matter nor from the upbuilding of matter into more complex atoms within a star or nebula, but from the process of atom-building in interstellar space.

Let us consider what are the most common elements in nature and how much energy would be set free as radiation if these elements are being synthesized, atom by atom, from the simplest atom of all—the hydrogen atom—which is composed of one proton and one electron, the two ultimate charges of positive and negative electricity.

Stellar Chemistry.

The hottest stars tell us that they contain a great deal of helium; cooler stars like Capella, Polaris, Arcturus, and our sun tell us of the abundance of iron and silicon in the stellar make-up; yet cooler stars tell of carbon atoms and molecules, while the gaseous nebulae record oxygen and nitrogen until recently unrecognized as such and called nebulium. Apart from this spectroscopic evidence, we have the analyses of many meteorites—54 per cent oxygen, 15 per cent silicon, 13 per cent iron, 13 per cent magnesium; and of the earth's crust (a chance fragment of a quite typical star)—55 per cent oxygen, 16 per cent silicon, 5 per cent aluminium, and lesser percentages of other elements, while the earth's core is undoubtedly chiefly composed of iron.

Now assume that somewhere in space four hydrogen atoms come together, rearranging their protons and electrons into the compact atom called a helium atom. The relative weights of a hydrogen and a helium atom are 1.00778 and 4.0, whereas one would expect the helium atom to weigh 4×1.00778 or 4.03112, since it contains four protons and four electrons while the hydrogen atom has only one of each. Where has the extra mass gone? Evidently the closer packing of the electric charges in the nucleus of the helium atom results in less energy content or mass, so that the excess energy represented by the figure 0.03112 is dissipated into space as radiation. It is always possible to evaluate the mass of a body as ergs of energy and to calculate the frequency of the radiation to which this energy would give rise, by means of a relation due to Einstein and to Planck:—

$$mc^2 = E = h\nu$$

where m is the mass expressed in grams, c is the velocity of light, E the energy in ergs, ν the frequency of the radiation and h a numerical factor known as Planck's constant. Knowing thus the frequency and therefore the wave-length of the radiation, it is possible to calculate its absorption coefficient by means of a somewhat complicated formula due to Dirac.

Millikan carries out these calculations and finds that the synthesis of helium from hydrogen would be accompanied by an emission of a radiation having an absorption coefficient 0.30 in very fair agreement with his experimental value, 0.35. Encouraged by this, he passes on to consider the synthesis of an oxygen atom and a nitrogen atom from 16 hydrogen atoms and from 14 hydrogen atoms respectively. The one process leads to a cosmic ray with absorption coefficient 0.074, the other to 0.086 or averaging the two, 0.080 as found experimentally. Carbon, another of the abundant elements being equivalent to 12 hydrogen atoms, would give rise to a radiation falling alongside of the oxygen-nitrogen group.

It takes 28 hydrogen atoms to build one silicon atom, and here again the absorption coefficient of the resulting radiation agrees closely with the experimental value—0.041 and 0.040. Not very different would be the radiation accompanying the synthesis of each magnesium atom from 24 hydrogens.

But what of iron, perhaps the most abundant of all the elements? If 56 hydrogen atoms unite suddenly to form one iron atom, a radiation would be emitted even more penetrating. This radiation, however, has not been detected. Nevertheless, one cannot but be impressed by the close agreement between theory and observation in the other cases.

Eddington's View.

It should not be supposed that this is the first time that synthesis of the atoms of other elements from the hydrogen atoms has been suggested as a source of radiant energy—far from it. As soon as relative atomic weights were accurately established and the relation between mass and energy known, this hypothesis arose quite naturally, but following the lead of Professor Eddington most people looked to the interior regions of the giant stars as the places where this upbuilding was taking place. The stars became in our thoughts the crucibles of nature in which the successively heavier atoms were being evolved, as in a fiery furnace of Nebuchadnezzar seven times heated. Not but that this picture had its attendant difficulties. The centre of a great star may be at a temperature of twenty million degrees or more, but is that hot enough? Professor Eddington's famous reply to such critics is well known, being briefly a courteous invitation to " go and find a hotter place."*

Professor Millikan declines that invitation and says, in effect, that it not a hotter but a colder place that is needed. It is in the regions of lowest material density and most nearly at the absolute zero of temperature where the hydrogen atoms are so quiescent that their kinetic energy is almost reduced to nothing—it is there that the synthesis of the elements will occur.

Which of these two views is correct? It is well, perhaps, to reserve our judgment until further and more convincing evidence is forthcoming. The latter hypothesis like the former has its difficulties which we must not ignore. Imagine all the matter in a great galaxy of a thousand million stars suddenly ceasing to exist as matter, its equivalent energy being all of the form of radiation traversing and retraversing without loss the same vast volume of space as the galaxy had occupied. Then in every 400 cubic feet there would be just enough radiant energy to form one hydrogen atom if it could all be concentrated into the material form of one proton and one electron. Imagining this miracle to have been accomplished, our galactic volume is now filled with hydrogen atoms, the density being one atom to each 400 cubic feet. Next picture the chance coming together of four of these atoms to combine as a helium atom, or 16 of them to form an oxygen atom, or 56 of them to form an iron atom, and so on. It is not an easy flight of the imagination, nor is it rendered less difficult by assuming it to take place very gradually during aeons of time.

A further criticism comes from Queen's University, Canada, where Dr. J. A. Gray claims that Millikan overlooks the effects of the secondary or scattered radiations in calculating the wave-lengths, which are actually shorter than those derived by Millikan.

The problem of the source of the penetrating radiation is thus not yet solved, but it has brought us face to face with alternative theories of atom building and of the annihilation of matter, the transformation of the energy of matter to the energy of radiation, and *vice versa*.

A Philosopher's Answer.

Possibly it is not too much to hope that the further study of the cosmic rays may yet throw light upon the vast cosmical processes. Are they indeed irreversible, or is Millikan right in regarding them as reversible? Most physicists would give the affirmative answer to the former question. Perhaps the reader, turning disappointed from this ebb-tide picture of the universe, will find comfort in the words of the philosopher, Dr. A. N. Whitehead, who states his belief in a universe " physically wasting," it is true, but " spiritually ascending " whatever that may mean to him, to you, or to me. *Quot homines tot sententiae.*

* See " Stars and Atoms " (Clarendon Press), 1927, p. 102.

Queer Customs in Native Africa.

By Captain W. Hichens.

Late of the Native Administrative Service, East Africa.

Native customs have to be so carefully observed by visitors to Africa that during the recent Royal Tour great care was taken to keep the Princes informed on this matter.

It seems unlikely that a well-bred white man visiting a native kraal in Africa could offend the black-skinned savage by breaking some rule of good manners or politeness, but the fact remains that no small part of the duties of the Princes' staffs during the recent Royal Tour in East Africa consisted of keeping the Princes informed of the remarkable rules of good manners in the many native kraals which were visited. The savage surrounds himself with a most complicated etiquette, notably in his ideas of hospitality, in his care for guests, and in his daily domestic life, and, as a rule, the savager the savage the stricter and more involved is his code of polite behaviour.

NATIVE HOSPITALITY.

The savage sets great store by free-handed hospitality, and as soon as the white man arrives in camp, kraal headmen send their folk with fruit, grain, and other foods.

One of the most extraordinary savage forms of politeness is to be met in the country of those famous warriors and one-time cattle-raiders, the Masai. Trekking through their *manyattas* or kraals one meets battle-scarred old veterans who relish a chance to come to the white man's camp to yarn of lion, elephant, buffalo, and other big game which they have hunted in more youthful days. One must be neither affronted nor surprised if, when one holds out a hand to one of these old men, he solemnly seizes it and deliberately spits into it. An insult?—not at all; but rather an act of knightly courtesy! Having thus greeted the white man, that old Masai warrior and all the menfolk of his clan, numbering many hundreds of battle trained spearsmen, have pledged their honour, their valour, their strength of arms in battle, to guard the white man as their guest from every ill that might befall him.

In the *ngut-en-rubeito*, the act of spitting, unpleasant as it may seem to us, the Masai warrior literally hands himself over, body and soul, into the command of his guest. Many hundreds of white men have travelled in Masailand, but few have had this honour of *ngut-en-rubeito* bestowed upon them. It is a form of greeting sparingly used, for the peculiar reason that having become possessed of a warrior's spittle, that is, of an actual part of him, an enemy could, the Masai believe, easily cause his death. To mix with clay a snip of a man's hair, or one of his teeth, or a little of his spittle, thought to be the very fluid of his soul, and to take the resulting compound to a witch-doctor, is one of the commonest as well as easiest ways of killing an enemy in this country of medicine-men and black magic. Say what you will of mumbo-jumbo, many a man does die of black magic set by some enemy who has stolen a bit of hair or piece of nail or some spittle or other "part" of him. So to spit in the hand of a guest is to put your life or your death into his hand.

For that reason no Masai would dream of spitting in his kraal in the way that some careless people spit in our streets and public places; and many a white man in this savage country has made himself an object of scorn and pity by thoughtlessly spitting in a native kraal. If a Masai must get rid of saliva, he carefully covers the spot with earth; but there are times when he spits ceremonially, as when he prays to Ngai, his sungod: he offers the god part of himself.

"OPEN HOUSE."

The poor hut of the savage does not lend itself to entertaining, but he keeps open house for all who come in good will, giving the best that he has.

He also spits when on his death-bed, into the hands of those whom he leaves behind, and they pass their hands over their faces so that they may keep, each for himself, at least some part of him who is departing from them into the Land of Ngai.

Not only the Masai but many other tribesfolk spit when they see the totem or sacred animal of their tribe, and therein lies another serious pitfall for the unwary white man. Nearly every savage tribe has its sacred animals, which must on no account be killed, harmed or even spoken ill about. Before British rule if a native even accidentally killed the sacred animal of his clan, he was usually put to death, his hut was burned down, and so accursed was he that even his cattle, sheep, goats and fowls were all slaughtered as unclean.

All sorts of animals are held sacred by different tribes—jackals, cockroaches, elephants, chameleons, duikers, bees, frogs, baboons, rats, lions, ants and monkeys, to mention but a few. It is so easy to offend every man, woman and child in a dozen kraals, quite unintentionally, through one's ignorance of their totems.

Once in the Ataturu kraals near Victoria Nyanza, whither I had gone to lay some witch-doctor murderers by the heels, I was most anxious not to affront the local chiefs, for they were none too friendly; but by one innocent action I nearly made them deadly enemies. As we trekked through a forest trail I noticed a particularly large bright green chameleon laboriously crossing the path. All my Ataturu porters stopped to look at it; or so I thought. I picked it up. The porters yelled with horror. "Put it down, Bwana, it will bite and poison you!" shrieked some. "It will give you leprosy!" shouted others. "If its claws scratch you it will make you blind!" warned others. "Well," I said, knowing the chameleon to be quite harmless, "if it is so dangerous you can kill it!" You could positively hear the shocked silence with which the porters greeted that remark, and I realized that I had literally "put my foot in it"; so I put that reptile on a bough and said, "It is a marvellous thing, seeing all ways at once, knowing neither time nor death (a native myth) and beyond the ken of man, for see, on the trail it was green, on the bough it is brown, and were it in the sunshine it would be yellow, this beast of wonder!"

That appeased the Ataturu, and later in the kraal I overheard them telling the chief how I had "spoken words of praise to one of the old men"; the "old man" being the chameleon, their totem, in which they believed resided the spirit of some long departed chief. Although this belief is now fading, most savages regard their sacred animals as the resting places of departed ancestors, so it is easy to realize how one may commit a grievous offence by shooting the wrong animal! Amongst the Nandi people, whom the Prince has seen, the hyaena is sacred. When a person is on the point of death in the kraals, his relatives take him out of the village into the bush and leave him for the hyaenas to devour.

The Great Beyond.

So it is that no Nandi will kill or wound a hyaena near his own kraal, lest that very beast be the spirit-home of some near relative. One of the gravest offences in the Nandi country is to imitate the cry of a hyaena, a thing, curiously enough, which one is often tempted to do, for the hyaena has a mournful moan as though he invited sympathy, and one feels like mocking him. But a Nandi man or woman who did so would either be turned out of the kraal, or forbidden to marry or punished in a similar drastic way; even a child is well flogged for such an offence. Who knows, in Nandiland, but what the cry of the hyaena in the quiet of the night is not the very voice of some dear chief or relative calling from the darkness of the Great Beyond?

Spirits and demons, real and imaginary, dead and alive, surround life in the kraals. One must not awaken

a native suddenly lest his spirit which roams the vast places of the world while he sleeps has not time to return into his body. A doorway is left for him; there is scarcely a native in the length and breadth of East Africa whose teeth, either two or more, have not been filed so as to leave a gap through which the wandering soul may depart and enter. The proper way to awaken a savage, and most savages sleep heavily, is to grasp his left ankle gently and squeeze it two or three times, whispering, "Amkeni! Awake ye!" Not "you," be it noticed, but "ye," the man and his soul. A chief or warrior or a witch-doctor can be very seriously offended by being suddenly routed out of bed; demons are always waiting to leap into his body in the place of his soul, and it is just when you wake him up with a jump that he opens his mouth in startlement and gives the demon his chance to get in! Maybe a stupid superstition; but that removes none of the offence which can so carelessly be given.

For a like reason one should never in any circumstances ask a native mother the name of the bonny piccaninny in her arms and then say, "What a fine little chap he is!" or praise him in any way.

WOMEN WHO SPIT.

Women of the Masai tribe amongst whom to spit is the acme of politeness. To the white visitor, this is one of the queerest of customs.

That is just the thing to attract the evil-eye and the malevolent attentions of *zimwe* or goblins which are always lurking in the kraal. They hear the baby's name, prick up their ears, as it were, and, from a native viewpoint, he is certain to be bewitched.

Bush Devils.

Indeed, in most kraals there is some evil-minded witch or wizard amongst the natives who is only too pleased to seize on such an opportunity and work "magic" by poisoning or other mysterious means and so extract fees in cattle, grain, or money from harassed parents whose children are "bewitched." For similar reason it is forbidden in most kraals for a wife to ask her husband what his business is when he goes out; the *ngogwe*, or devils of the bush, might easily overhear, or, more literally, some enemy might overhear, and bewitch him, so that his project, a hunting trip, or a honey-foray, could easily end in disaster. The very wind has ears and whispering tongue in the wilds of Africa.

An innocent crime which many white men commit, so that they get themselves disliked in the up-country kraals, is to walk over a native's shadow. This is so readily avoided by always keeping between the sun and people one passes, that the savage cannot understand how white men can be so careless as to break this rule of manners. Most savages believe that their shadows embody their souls, and if you tread on a man's shadow you can have no other motive than to cause him harm. Even the ordinary kraalsman resents it, while to most of the chiefs and especially those who are rain-doctors and medicine-men of the gods Mbula, Nzua and Munankali, the gods of rain, sun and harvest and health, no greater insult could be conceived.

The savage is most punctiliously polite, too, in the matter of greeting. As you trek along the trails you meet natives of different tribes who all greet you cheerily and politely in their different languages. You may not understand what they say, but unless you are an ill-mannered person you must reply, for their greetings are usually most courteous. "Wela! Walongola iza!" a Mniramba will cry, "Light of the dawn upon you! May your going be good!" And he means it. A Masai will say, "Sopai! Muran-ju! God go with you, O warrior!" And what is easier than to reply, "Takwenya! And go thou happy on your way!" We would be better in our white towns for some of these savage manners.

Superstition plays a big part in good manners in most kraals. Never must you ask an unmarried Mangati girl to cross a river or to fetch anything from the roof of a hut. Hut roofs are flat in that

country and such things as groundnuts, pumpkins and fruit are spread out on them to dry or ripen. But if an unmarried Mangati girl gets her feet wet in running water or climbs on to a roof she will turn into an elephant—so says the law of the tribe. If you enter a witch-doctor's kraal, never wear anything red or the curse of the devils of the black man's underworld will smite and rend you. If you go into a rain-doctor's kraal always wear something blue; it is the colour of Mbula, the rain-god, whose priest you are to meet. If you hear the moan of the suka drum, never ask who has died. No native ever "dies." He "goes through the roof," and he is not "dead" to be spoken of as such until after he is buried; and then you must not mention his name and his death in the same sentence or you will affront both his spirit and his living relatives.

If one tries to observe these native rules of good-breeding you may go into the savagest kraal and be received with open-armed hospitality.

The Perfect Host.

I once lost my way in the bush country of Tanganyika, and after a long trek came late at night to a lonely hut where lived a solitary old savage, very feeble, half blind, and almost starving, for it was famine time. I had had no food nor water since morning and with heat, fatigue and thirst my throat was parched and I ached for a meal. He produced two pots, one of *migai* or weak grain beer, another into which he cut up a pumpkin with water and boiled it. I noticed he handled that second pot very carefully. He ate nothing; but I enjoyed my meal with that old man; he made me a bed of rushes and sprinkled clean ashes under and around it to keep off ants and vermin. In the light of dawn I looked over his tiny hut and plot. He had given to me, a white man and a stranger, the last dreg of beer and the last morsel of food, the pumpkin, that he had in the world. A scraggy mangy dog was licking out the pumpkin pot. "Why did you take such care of that pot," I asked, "look at the dog, he'll smash it!" "It is the dog's feeding pot!" said the old man, "That is why I cooked your food in it."

I thought that over for a bit. As a fact, the dog, Mbwa, was the totem animal, the sacred animal, of that old man's tribe. He himself would never have dared eat from that pot, but he gave it to me; it was an honour. He had given me all that he had and the best that he had. I have been into the houses of many white men, great and small, but I still think of that poor half-blinded, starving old man in the scrub around Eyassi as the most perfect host of them all.

Book Reviews.

Game Birds. By Douglas Dewar. With Wood-Engravings by E. Fitch Daglish. (Chapman & Hall. 42*s*.).

Fully as we appreciate the difficulty of finding titles for bird books, we can hardly help commenting on the fact that this one is particularly misleading, since it is borne not by a work upon game birds in general, but by a sort of handbook (written partly from an ornithological, but largely from a sporting standpoint) to the game birds and certain of the wildfowl of the British Isles. Nor is this the only fault we have to find with Mr. Dewar. He seems incapable of properly verifying his references, and as these are exceedingly numerous, the value of his work is seriously compromised. Not only do we get obvious mis-spellings of names, like "Shenk" for "Schenk" (p. 195), or "Meinertz" for "Meinertzhagen" (p. 100), but we find the great snipe credited with at least five inches beyond its maximum measurement, so that it comes out considerably bigger than a woodcock, and we are invited to communicate about rings with the Editor of *British Birds* under an address in the wrong postal district (p. 170), and about something else with the *Irish Naturalist*, a journal which has long ceased publication.

The author states that "of a large number of teal ringed in the British Isles only seven seem to have been recovered" . . . although a glance through the last few lists in *British Birds* yields over thirty such records, which, if he had been aware of them, must considerably have modified Mr. Dewar's inferences on the proportion of resident to migratory birds. The story of the nomenclature of the partridge on p. 65 makes a great point of Ray (1628-1705) being a successor of Linnaeus (1707-1778). The difficulty over the French saw "A la Saint Jean Perdraux volant" disappears if one remembers that in the meantime the calendar has been docked of eleven days.

If Mr. Dewar would pay more attention to detail the value of his writings would be greatly enhanced, but although on this account his authority is never altogether to be relied on, he is usually well worth reading. In the present instance, that is most emphatically the case; we have few writers who are so consistently awake to the underlying problems—what Mr. Edmund Selous has called the realities of bird life. One rarely agrees with everything that Mr. Dewar has to say, and one never depends on his accuracy, but one hardly ever reads anything he has written without being considerably stimulated, and feeling that one has learnt a great deal. The reviewer is inclined to believe that despite his obvious blemishes Mr. Dewar possesses this faculty of stimulating the field observer, and making him see fresh problems and new sides to familiar ones to a higher degree than almost any other living writer. He presents a more reasoned, if not a more reasonable, view of the living bird than any of his competitors. His recent books on limited subjects must be treated together in order to judge him fairly—his case, if often over-stated, is in many respects both original and convincing. On the whole he is also consistent, although the passage on p. 174 about the impression made by birds of prey is absolutely contradicted by his remarks on the same point in *Birds at the Nest* (p. 192).

Mr. Daglish, in his woodcuts, has succeeded in finding a fresh and interesting treatment of the most hackneyed group in all bird portraiture; he is very much to be congratulated.

E. M. Nicholson.

The Nature of the Physical World. By A. S. EDDINGTON. M.A., LL.D., D.Sc., F.R.S. (Cambridge University Press, 12*s.* 6*d.*).

The subject matter of this book is the Gifford Lectures delivered by Professor Eddington in the University of Edinburgh during the period from January to March, 1927. The immediate sentiment that suggests itself to the reviewer after reading the book is that Edinburgh is heartily to be congratulated both on its Gifford lecturer and his lectures.

The educated layman will assuredly regard this book with delight on three separate counts:—(1) It deals in the most entertaining manner with perplexing problems that he will immediately recognize as intimate and fundamental; (2) It explains the true territory of scientific enquiry and defines the limits of legitimate scientific pronouncements on physical matters; (3) It is written by a scientific authority of the highest eminence, but nevertheless one whose humility expresses itself in sympathetic help and quick humour which will be found to be remarkably efficient in oiling the reader's mental machinery when the subject matter becomes difficult.

The essential symbolism of science is a fundamental axiom which, in the light of present knowledge, should be included in every student's curriculum. Its omission hitherto may very well have contributed to the dogmatism which is discernible (and deplorable) in many of the lesser scientific opinions which are showered upon us nowadays. The philosophical perspective contemplated by Professor Eddington is as refreshing as the nineteenth hole on a hot summer day.

A considerable amount of space is devoted to a discussion of the theory of relativity and its concomitant conceptions. We have never seen it dealt with in a more admirable or readable manner, but Professor Eddington's great ability merely confers additional emphasis on the known difficulty, if not impossibility, of treating these matters from a non-mathematical standpoint. The expression relativity is undoubtedly the mathematician's pidgin, and a great deal of heartburning would be avoided if this simple truth were more generally realized.

From the point of view of the scientist it is good to live in the present age when the character of the universe changes (mathematically) from waves to pellets and from pellets to "wavicles" with kaleidoscopic brilliance. Nevertheless, such an environment demands a steady head, and it is scarcely to be wondered at if the scientist becomes so engrossed in calculations that he stands in danger of forgetting that the rainbow is beautiful as well as numerical, or that the word "substance" has a very tangible meaning for the man who has to pace the bedroom floor through the watches of the night with his progeny in his arms.

The last four chapters of the book are in many ways the best. In the preface the author says, "I release it now (the book) with more diffidence than I have felt with regard to former books." It may be that he has these last chapters in his mind, and, if so, he may be reassured. It is more than difficult to reconcile the view point of the metaphysician and the scientist, but the system of philosophy which can really contemplate the two against a background of *something* that is more real in consciousness than either, surely offers a realization of true happiness. Professor Eddington has performed a great service to science, and at the same time he displays a high ideal for both the scientist and the philosopher. In the past few years the borderline between science and religion has been approached very nearly. It is impossible that they should not intermingle and harmony can only be attained by painstaking enquiry and sympathetic understanding; therefore it is to kindly experts like Professor Eddington that we must look for guidance in these difficult times.

It is a melancholy thought that in spite of such books as this, the too rigid scientist will probably continue to invest his God with a bachelor of sciencehood and the devoted metaphysician will still "discourse in novel phrases of his complicated turn of mind." Thus it may come about that the elusive jade Truth will ultimately be found in the consciousness of that despised individual "the ordinary man."

V. E. PULLIN.

Beneath Tropic Seas: A Record of Diving among the Coral Reefs of Haiti. By WILLIAM BEEBE, Sc.D., Director of the Department of Tropical Research, New York Zoological Society. (Putnam. 15*s.*).

All those who have read "The Arcturus Adventure" will welcome the present volume, in which we meet again with the naturalist walking on the sea floor. Provided with a glass-windowed helmet resting on the shoulders, into which air is pumped from above, he is let down from a boat and finds himself in that wonderful world at the bottom of the sea—a world of colour unlike anything to be seen above, where animals take the place of flowers, in many cases surpassing them in brilliancy, and where the fishes are so tame that they take no notice of a mere human being amongst them. The ship *Lieutenant* is Dr. Beebe's research vessel, and this new voyage of exploration has its headquarters in Haiti. A preliminary note appeared in *Discovery* about two years ago, when the author set out.

Many of the creatures discovered are new. They have not yet been described nor given scientific names. It is a wonderful life wandering along among the fishes and collecting under the sea—even taking photographs, making pencil notes on a zinc pad, and sketching in colour.* The frontispiece is one of these colour sketches, yellow and blue predominating, painted by Mr. Zarh Pritchard many feet beneath the water on a coral reef in Tahiti. These sea pictures remind one of Hans Andersen's fairy palaces under the water. The creatures which sound terrible to the layman have no terrors for the naturalist, who revels in this new world. In fact, the bottom of the sea in Haiti is apparently as safe as most places.

It is, however, not only the life at the bottom of the sea which is described, but all kinds of dredging, seining and tow-netting, and observations on the shore. Huge jelly-fishes were caught each sheltering hundreds of little fishes, just as the large blue species shelter the tiny whiting and horse mackerel in our own seas. Small fishes resembling hedgehogs inflate themselves perhaps in order to look terrible, and succeed in looking very much like sea-urchins. It is shown that when all together they make a formidable prickly solid mass which absolutely prevents their enemy the Gar-fish from eating them. Woe betide the "Puffer" who leaves the main mass! In spite of his burr-like body he is swallowed whole by the voracious Gar.

The Fiddler crabs on the shore and their breeding habits; the giant sponges which may weigh well over a hundred pounds and which harbour innumerable interesting small creatures inside them; the Gurnard which can almost fly—all these are described in a delightfully entertaining manner. We are taken in an aeroplane to be shown the reefs from above, and by way

*Probably the first photographs ever taken under the sea, however, were those which Ernest and George Williamson exhibited at the International Motion Pictures Exhibition held in New York in 1912. Though made in more shallow waters, these early pictures attracted much attention.

of variety study the birds. The description of a humming-bird's nest and the feeding of her two hideous grub-like offspring is a gem never to be forgotten.

The amount of new work done on this expedition (the Tenth Expedition of the Department of Tropical Research of the New York Zoological Society) is large, and the final results will be published in a series of scientific papers by Dr. Beebe and his staff. These should be very interesting. At the end of this volume the author adds appendices showing the approximate cost of such an expedition.

MARIE V. LEBOUR.

The Tragedy of the "Italia." By DAVIDE GIUDICI. (Ernest Benn. 12*s.* 6*d.*).

Signor Davide Giudici represents the great Milan journal the *Corriere della Sera* in Berlin. He was sent at short notice last May by his paper to Norway to join in the search for the survivors of the disaster to the airship "Italia" on its return to Spitsbergen from a cruise over the North Pole. He was so fortunate as to be the only non-Russian journalist on board the Soviet ice-breaker the "Krassin," which after many adventures succeeded in reaching first one marooned group and then another. This book accordingly is not a scientific work; it is a faithful account simply and graphically written of a series of the most extraordinary adventures which have ever been recorded in the history of Polar exploration. Judged from this straightforward point of view, it is astonishingly complete.

Signor Giudici actually saw everything and everybody that mattered, except the unfortunate party who were carried away in the balloon after the airship had crashed on the ice. No word of these excellent men has since been heard, nor most unhappily is there any clue to the fate of Amundsen, who intrepidly set out in an aeroplane to help in the work of rescue when he heard the news of the disaster. Amundsen, however, comes into Signor Giudici's narrative, inasmuch as the journalist saw him before he started on his gallant attempt, and obtained his views on the prospects of rescue. In the beginning the outlook for the survivors did not seem very favourable, and in reading Signor Giudici's narrative it seems almost a miracle that the "Krassin" ever succeeded in forcing her way through the ice to the rescue of the main party in the Red Tent and of Zappi and Mariano, who were picked up some distance away, after their forlorn effort to walk to the nearest point on the coast had proved a complete failure.

The reader will naturally scan very carefully the chapter in which the author gives the account of Zappi and Mariano to discover if any fresh light is thrown upon the dreadful tragedy of Dr. Malmgren's death on the ice. Nothing, however, is added to the information already in the possession of the public, except, perhaps, the impression conveyed that the two surviving members of the walking party took it for granted that they had no option in the matter but to act as they did.

The main story is that of the heroic efforts of the officers and crew of the "Krassin" to get through the ice in time to make the work of rescue effective. It is clear that they were only just in time to save the lives of Zappi and Mariano, who were in much worse straits than the men in the Red Tent. The Russians deserve the gratitude of the whole world for a very fine performance conducted in what the Englishman would regard as the most sportsmanlike spirit.

This book is no doubt written in a popular strain, but it is intensely readable, and gives an insight into the dangers of the Polar Sea which might easily be missing from a more technical treatise.

G. R.

The Harveian Oration, 1928. By SIR HUMPHRY ROLLESTON, Bart. (Cambridge University Press. 3*s.* 6*d.*).

When Harvey had completed his discovery of the circulation of the blood he planned a work upon the diseases of the circulatory system, but the design was never carried out or else the work was lost when his lodgings in Whitehall were plundered by the Roundheads in 1642. Sir Humphry Rolleston, the King's physician, has now taken up the project, and in this year's Harveian Oration summarized the progress of our knowledge of the physiology, anatomy and pathology of the circulation. But the structure that has risen on the basis of Harvey's discovery is so vast that a description of it in one lecture is of necessity very condensed and, though full of interest and suggestion to the physician, it cannot be expected to appeal strongly to the layman, to whom the architecture of the subject is unfamiliar. Yet the ordinary reader may be interested to learn that he owes a favourite drug, partly at least, to "a teleological process now rather unusual" which led Maclagan in 1874 to argue that since acute rheumatism was, like malaria, "miasmic in origin, a remedy for it would be most hopefully looked for among those plants and trees whose favourite habitat presented conditions analogous to those under which the miasm seemed most to prevail," and directed his attention to the willow, the bark of which was known to contain salicin, a substance that has since been improved into acetyl salicylic acid or "aspirin."

The book is a great deal more than an elegant memorial of ancient and modern achievement. It is amplified by a very extensive bibliography, to which even the least medical reader might be tempted to refer in order to find out what motives prompted Messrs. Lower and King in 1667 to transfuse "an indigent Bachelor of Divinity at Cambridge with the blood of a sheep" and what was the result of their experiment.

Sir Humphry Rolleston's scholarly prose is well matched by the distinguished typography of the Cambridge Press, and this book should have a place in the library of every physician, not only for its historical value but also as a conspectus of recent research into the physiology and pathology of the circulatory system.

F. A. H.

The Unconscious in Action. By BARBARA LOW. (University of London Press. 5*s.*).

With the sub-title "Its Influence on Education," the subject of this book is appropriately introduced by Dr. Percy Nunn, Professor of Education in the University of London. His foreword points out that psycho-analysis is still regarded by certain eminent scholars as "one of the eccentricities of the present age," while, on the other hand, so expert a critic as Professor William McDougall regards Freud as having "done more to advance psychology than any student since Aristotle." As is so often the case with opposing opinions, both contain something of truth: the expert is more likely to be the nearer of the two, but "there is some ground for the layman's view." Probably in writing this last sentence Professor Nunn had in mind the fact that Miss Low definitely avoids suggesting that the teacher should himself attempt to apply psycho-analytical methods to his pupils. "But he can," says the author, "do

exactly what he now does in relation to the school doctor—that is, by means of first-hand observation and wider understanding, he can bring to the analyst . . . those children who are in need of expert treatment."

The book does, however, discuss on what grounds the belief is justified that the relation of teacher to pupil is of much more fundamental importance than has generally been realized hitherto. Miss Low does not endorse the abolition of all punishment or try to excuse every fault as being of temperamental origin. In short, her book provides a cautious and valuable introduction to a very difficult subject.

Wireless, the Modern Magic Carpet. By RALPH STRANGER. (Partridge. 3s. 6d.).

In the preface of this volume the author states as his opinion that it is "extremely fortunate that broadcasting in Great Britain has been entrusted to men and women whose conspicuous practical ability is guided and exalted by splendid idealism. The British Broadcasting Corporation is easily the most efficient organization of the kind in the world. If this book will help ever so little to enable more people to enjoy and benefit from the transmissions of the B.B.C., I shall consider myself amply rewarded."

Yet from all quarters we continually hear complaints about the programmes broadcast by the B.B.C., many from those who, though possessing costly wireless sets, do not know anything of the difficulties either of transmission or reception. This book is for the amateur, and he will find there both an instructive and easily understandable scientific account of the component parts of his wireless apparatus, as well as a stimulus to further study in order to be able to obtain the very best results from his set. In many cases he will doubtless find that his complaints are caused more by faults in reception due to amateur ignorance than to a true desire for a different type of programme. There are books on wireless of all types, but this is indeed one that will be of great service to all who wish to understand their receivers.

Gentlemen Unafraid. By BARRETT WILLOUGHBY. (Putnam. 15s.).

The author of this series of sketches of the Far North was born and bred in Alaska, that land of peculiar charm. Some of her early years were spent voyaging in northern waters in her father's schooner, the *Tyee*, and most of her life has been spent in that region of winter cold and summer fertility. She is thus competent to outline life in this region that she does well, in her descriptions of the exploits and adventures of six pioneers who have undertaken their share of the hardships which the opening up of any such area to human endeavour always entails.

The exploits of the champions amongst the trail-blazers and swift-water pilots are ably and graphically described, but perhaps the most thrilling of the adventures outlined are those of Scotty Allan, King of the Arctic Trails, who introduced the sport of dog-racing over the frozen northern wilds. He it was who won first place three times in that famous race of four days' and four nights' duration—the All Alaska Sweepstakes, first run in 1908—as well as three second and two third places.

The chapters on George Watkin Evans, the mining engineer, and Dr. Georgeson, the "plant wizard of Alaska," describe the less spectacular work of two men who, though little known to the general public, worked hard in the interests of civilization in the northernmost State of the Union.

Queer Fish: Essays on Marine Science and other aspects of Biology. By C. M. YONGE. (Routledge. 5s.).

Blue Blood in Animals and other essays in Biology. By H. MUNRO FOX. (Routledge. 5s.).

The "Science for You" series contains these two books which will well repay a careful study. The last twenty years have seen the publication of many such series with the aim to "popularize" science or to disseminate the latest results of patient research amongst the non-scientific mass of the population. These series of essays gain a high place among similar publications for their extensive range of interesting subjects as well as their attractive style and manner of presentation.

Researches in biology have recently led to most remarkable and far-reaching results, and these essays give the reader a very clear idea of their trend. The problems of varying density in fish population; the researches in tissue culture and their possible relation to a future cure for cancer; regeneration in the animal kingdom; the determination of sex; the problem of blood relationship; the extent of colour blindness and the question, "Is death inevitable?"—these, and many other problems, solved and unsolved, are all dealt with in a straightforward and simple manner which so largely contributes to the attraction of reading. It is interesting to note that certain of the subject matter in "Queer Fish" has previously been published in *Discovery*.

Marvels of Modern Mechanics. By HAROLD T. WILKINS. (Fisher Unwin. 10s. 6d.).

The author has missed few realms of human endeavour which have been altered or revolutionized by modern scientific achievement in this survey of modern mechanical marvels. In this second edition accounts are given of the successes and problems attending the work of salvage on wrecked shipping; of the discovery of rich archaeological treasures by the most modern scientific methods; of the wonderful developments in wireless and in the devices used to ensure the safety and comfort of passengers by sea, air and underground railway; of our present knowledge of the atom and the ever-present benefits we derive from sunshine, and of the revolution in transport started by the invention of the Diesel engine. These, amongst others, show how completely modern civilization relies upon the ever more complicated inventions which form the very basis of the present standard of life—but also how dependent men are on science, whether employed for constructive or destructive ends.

Guildhouse Lectures.

THE Lecture Committee of the Guildhouse, Eccleston Square, S.W.1, is holding a conversazione on the 11th May, with the general object of illustrating the influence of science on modern thought. It is expected that the subjects discussed will include astronomy, which has changed man's ideas of the universe and of the place of the earth in the universe; geology, which has changed his ideas of the earth, especially with regard to its age; biology, which has changed ideas of the human race; and applied science, which by enormously improving means of communication has increased knowledge of the earth and its inhabitants. The subjects will be demonstrated by lectures and exhibits; primitive inventions which have led to great discoveries will be emphasized. All interested are invited to obtain particulars from the Secretary.

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